

NOVEMBER 1969

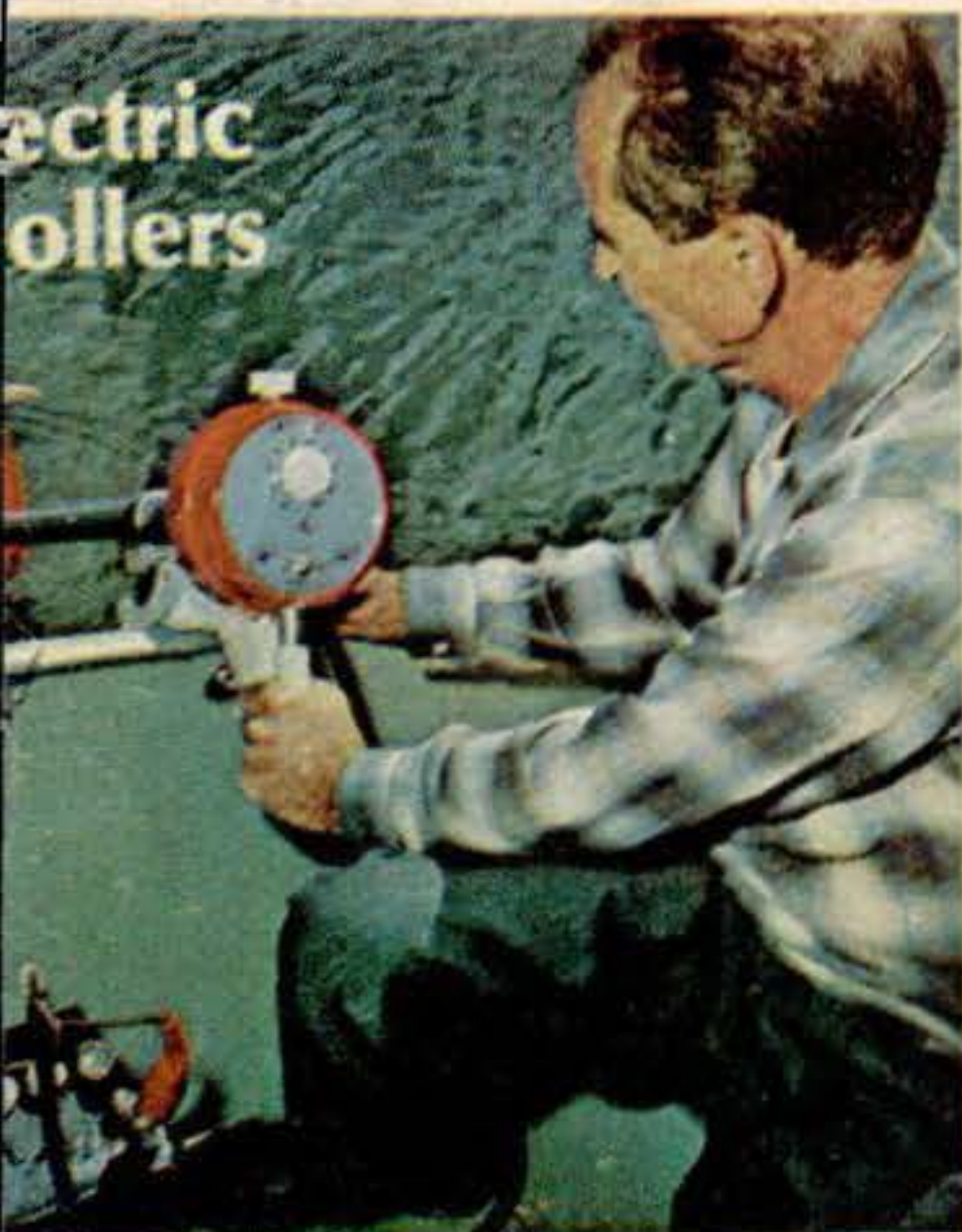
50 CENTS

Popular Science

THE *What's New* MAGAZINE

AIR BAGS:

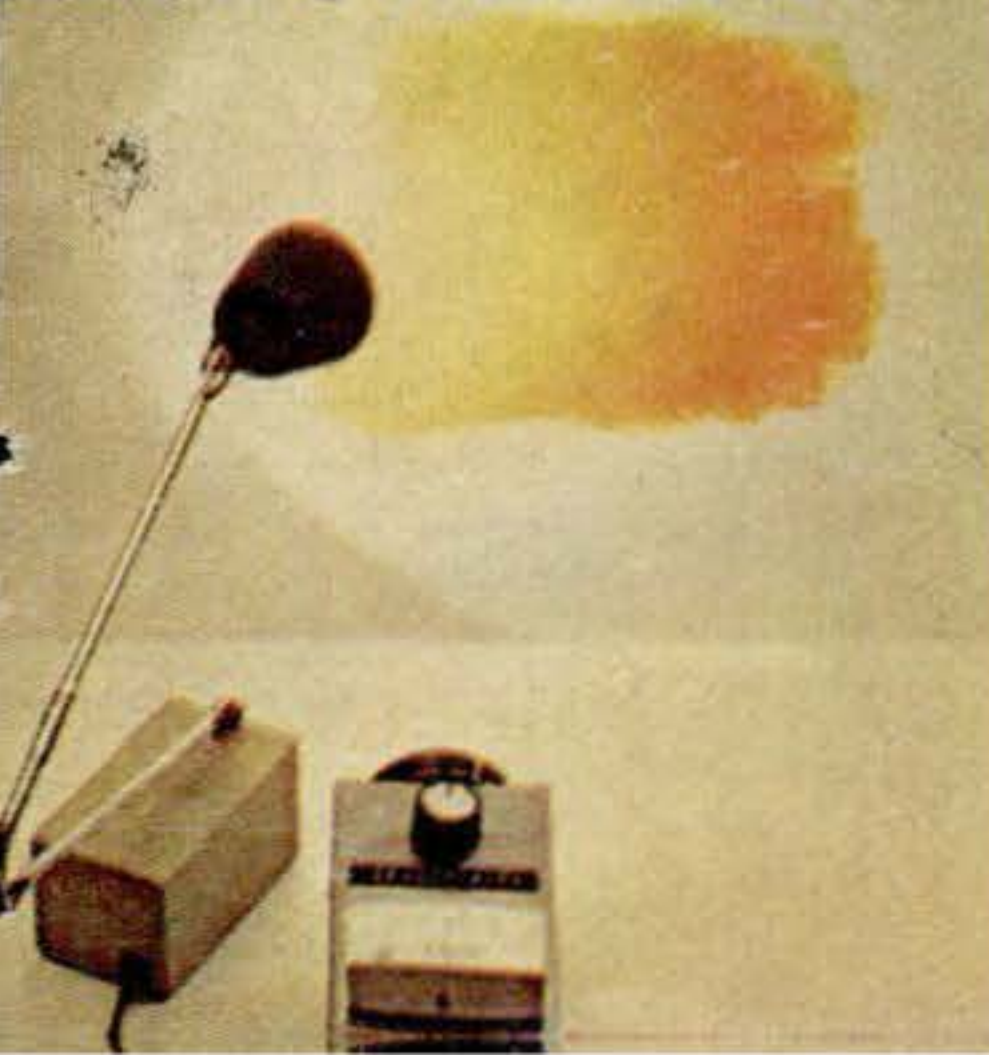
Will They Help
You Survive
"Fatal"
Car Crashes?



The Truth About
Limited-Slip
Differentials

New Underwater
Breathing Systems
By SCOTT
CARPENTER

Take a Colorimeter



WHAT IT'S LIKE TO FLY
THE NEW JET BELT

By Test Pilot Robert Courter

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NOVEMBER 1969 | 1

HIGHLIGHTS OF THIS ISSUE:

Flying the New Jet Belt By Test Pilot ROBERT COURTER **PAGE 55**

Exclusive PS report tells how Bell's new man-jet turns you into a flying machine.

New Underwater Breathing Systems By SCOTT CARPENTER **PAGE 72**

Revolutionary scuba gear will let men work, live 1,000 feet beneath the sea.

Will Air Bags Help You Survive "Fatal" Crashes? **PAGE 88**

Hard crash triggers inflation of pillows to save both driver and passengers.

Those Sneaky Little Electric Trollers **PAGE 94**

New popularity comes to the silent electrics and their "no-hands" controls.

The Truth About Limited-Slip Differentials **PAGE 118**

We tested two 4-4-2 Oldsmobiles—one with, one without. Results may surprise you.

COVER PAINTING: Jet Belt—James E. Bama; PHOTOS: Electric trollers—Tempo Products Co.; Colorimeter—Orlando Guerra

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- Desk-Workbench for a Youngster (complete with PS lie-flat blueprint)
- World's Tallest Chimney Lifts Pollutants Above the Clouds
- A Pilot's-Eye View of the Fabulous 747
- Why Not Buy a Good Paintbrush?
- How I Learned to Ski Electronically
- Build a Shelter for Your Snowmobile
- Install Liquid "Chains" on Your Car
- How to Get in on CB Radio . . . and more

. . . HOME AND SHOP

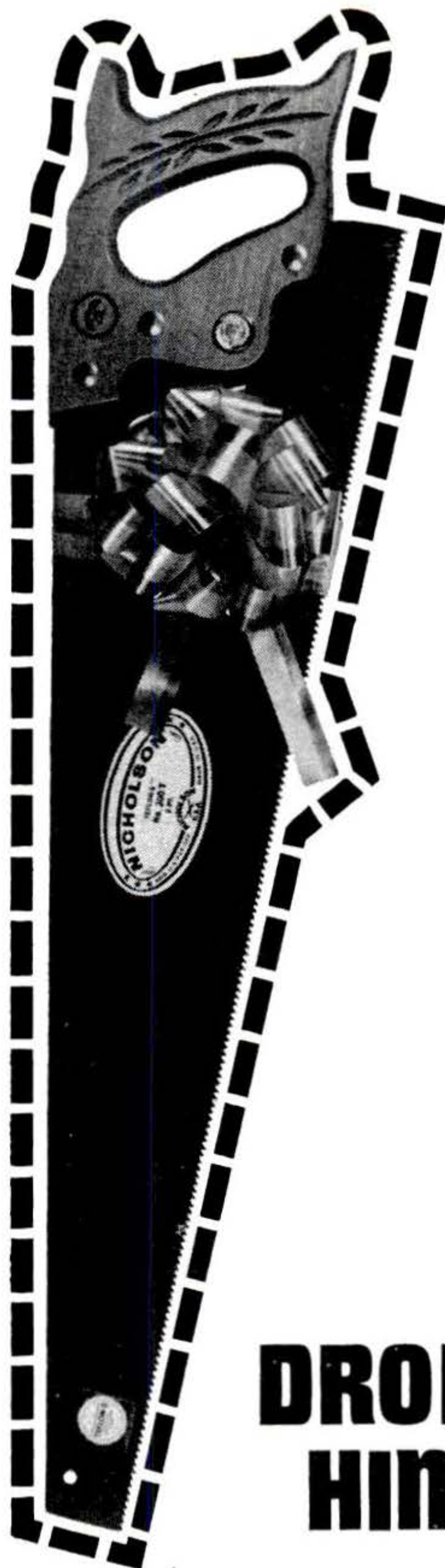
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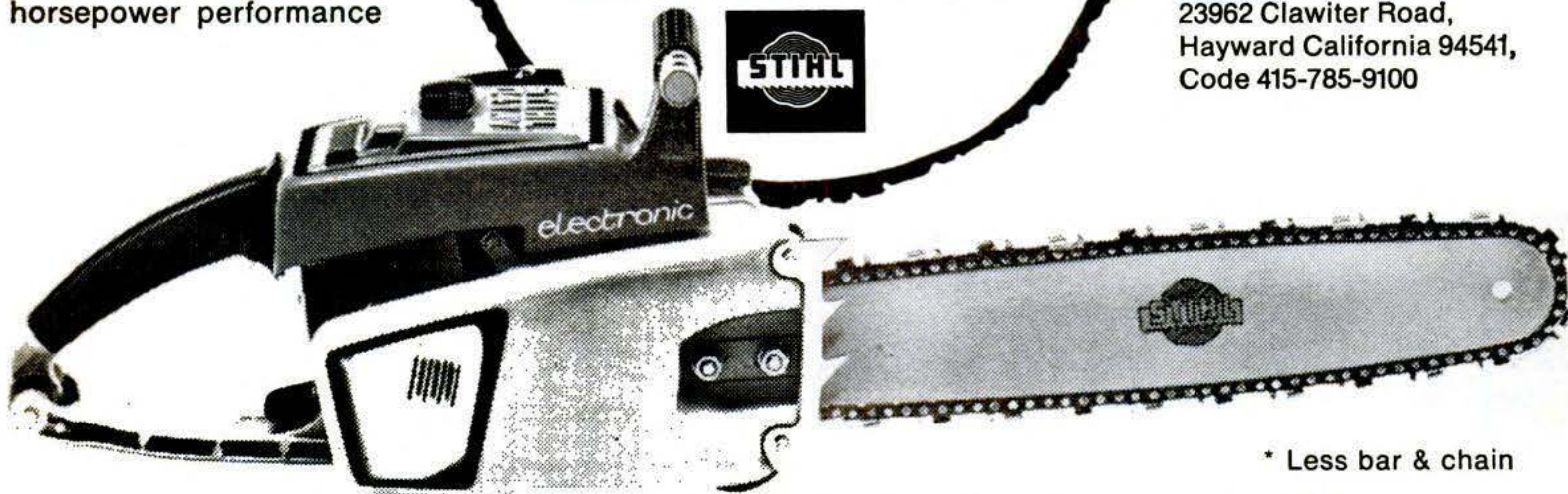
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PS Readers Talk Back

Should sub-rescue vehicle do research?

Being one of the many hundreds of men stationed aboard submarines, I was extremely interested in "Escape From the Deep" (Sept.). Naturally, submariners are concerned about being rescued if an accident should occur. But the article's last sentence bothered me. It says that the DSRV could help mankind explore and develop the undersea domain between rescue missions. I seriously doubt that submarine accidents will be set up on schedule, regardless of how organized the Navy tries to be. How will the rescue sub be able to reach stranded submarines within 24 hours if it is out exploring our undersea domain?

O. G. WATSON, ET1-SS,
Groton, Conn.

Adventures on a flying saucer

I was at the beach when I saw "Ski on a Flying Saucer" (Aug.), so I decided to try it. I asked a lumberyard to cut a 40-inch disk and then I slapped a couple of coats of paint on it, revved up our 6-hp. outboard—and wow! With a little practice, I



was able to cross the wake. It even has some of the best water skiers in our bay asking for rides. Thanks for a great article.

WILLIAM EPES, Buffalo, N.Y.

Gravity waves

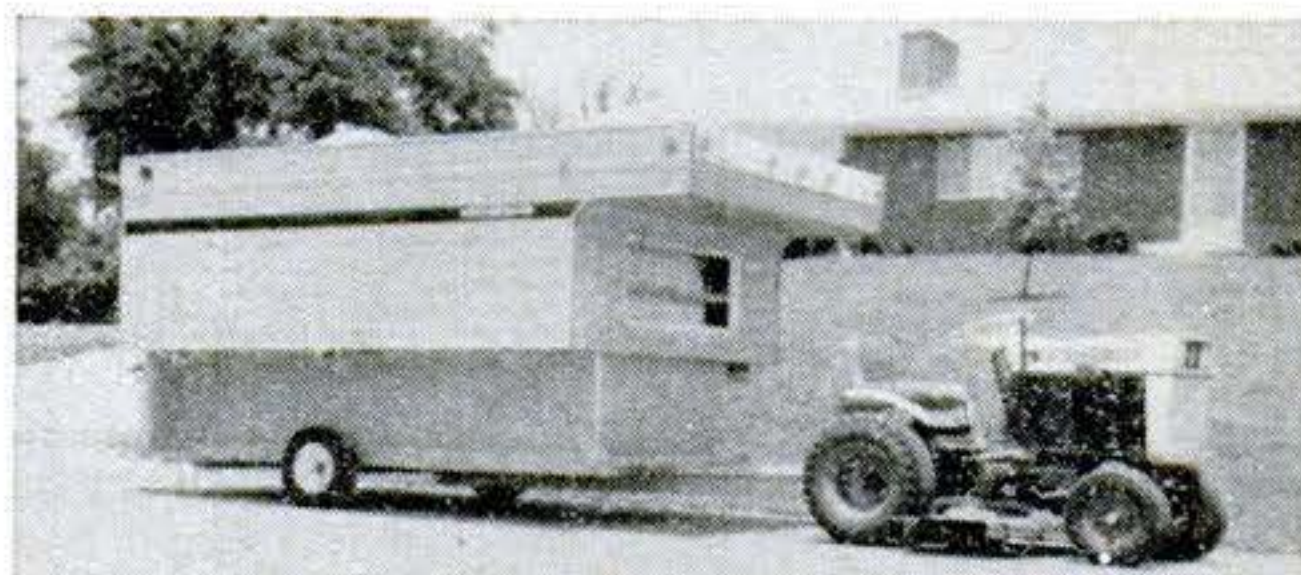
I can just imagine how important it will be if we can develop new devices to control the newly discovered gravity waves (Science Newsfront, Sept.). It could lead possibly to the control of gravity itself. Buck Rogers' anti-gravity belt would come into effect. Or it might produce new ways of sending rockets into space. It's unlimited. As Arthur Fisher says in his article, "It may help us solve the riddles of the quasars

and pulsars, and even of the universe itself." My thanks to Mr. Fisher for his contribution to public knowledge.

M. CARRILLO, A1C, March AFB, Calif.

Builds a camper caddy

PS readers indicated in past issues that they would like to have a camper caddy



This one I built might do the job for them. I made mine from eight feet of 2-by-4 and a boat trailer axle and wheels. The trailer is assembled with 1/4-inch wagon bolts. You need only a 1/4-inch drill, a saw, and a wrench to build the caddy. The job took about two hours and the materials cost about \$60.

JURI VOLMER, Xenia, Ohio

Contradicting Einstein

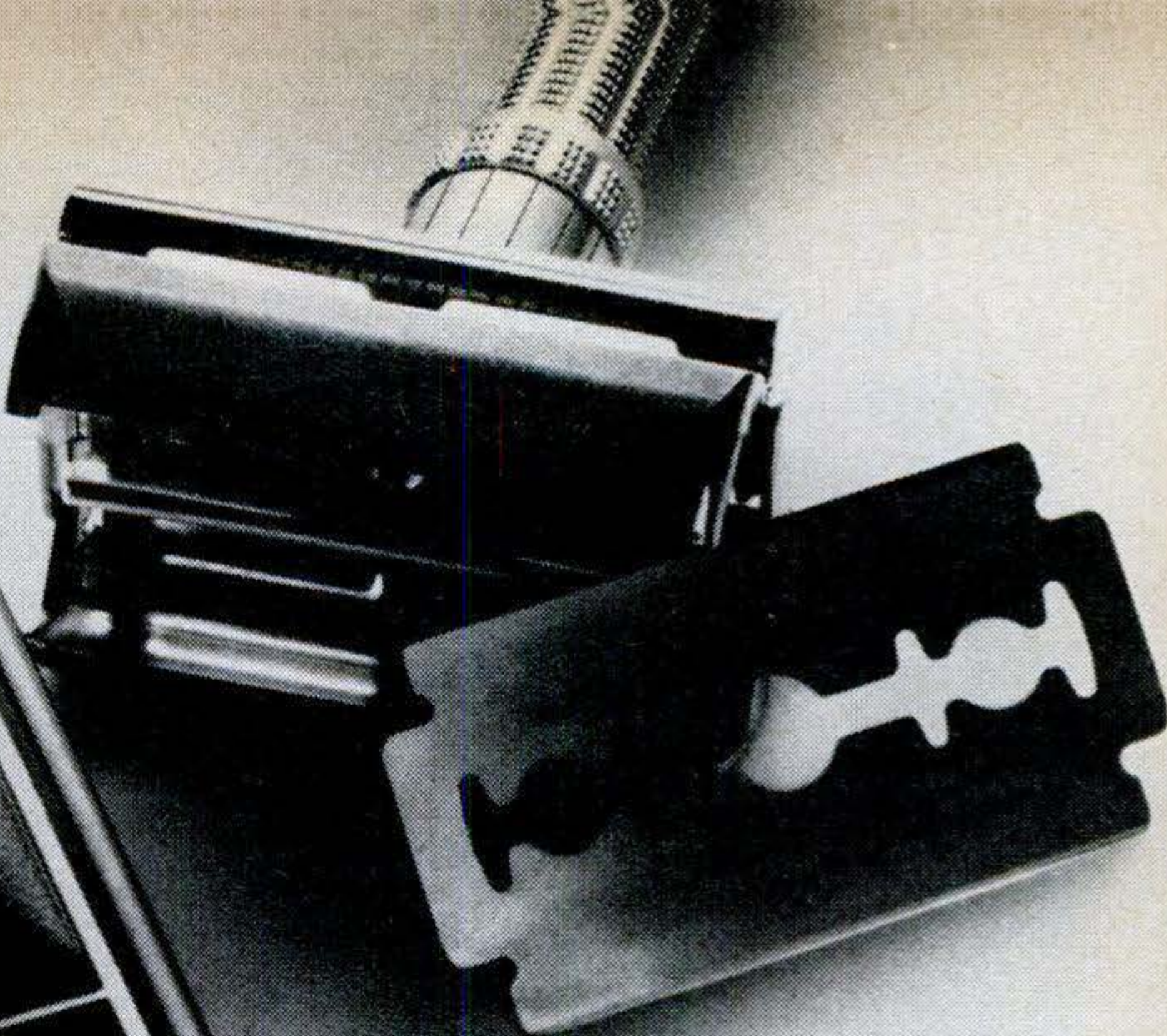
William T. Thomas, Jr., says in Readers Talk Back (Aug.) that "Recent studies of the planet Mercury have shown that the velocity of light reflected by it can be increased by twice the planet's orbital velocity."

If this is true, then it seems to suggest the fallacy of the Einstein speed limit (roughly 186,000 miles per second), particularly with respect to light emissions from stars and planets that revolve. Does this not suggest reevaluation of space distances? And if so, what effect would the more accurate calculations have on the mass and density of quasars and nebula? Involving as it does so many unknown factors, speculations on the subject appear to be far reaching.

ETHAN GRANT, Salem, Ore.

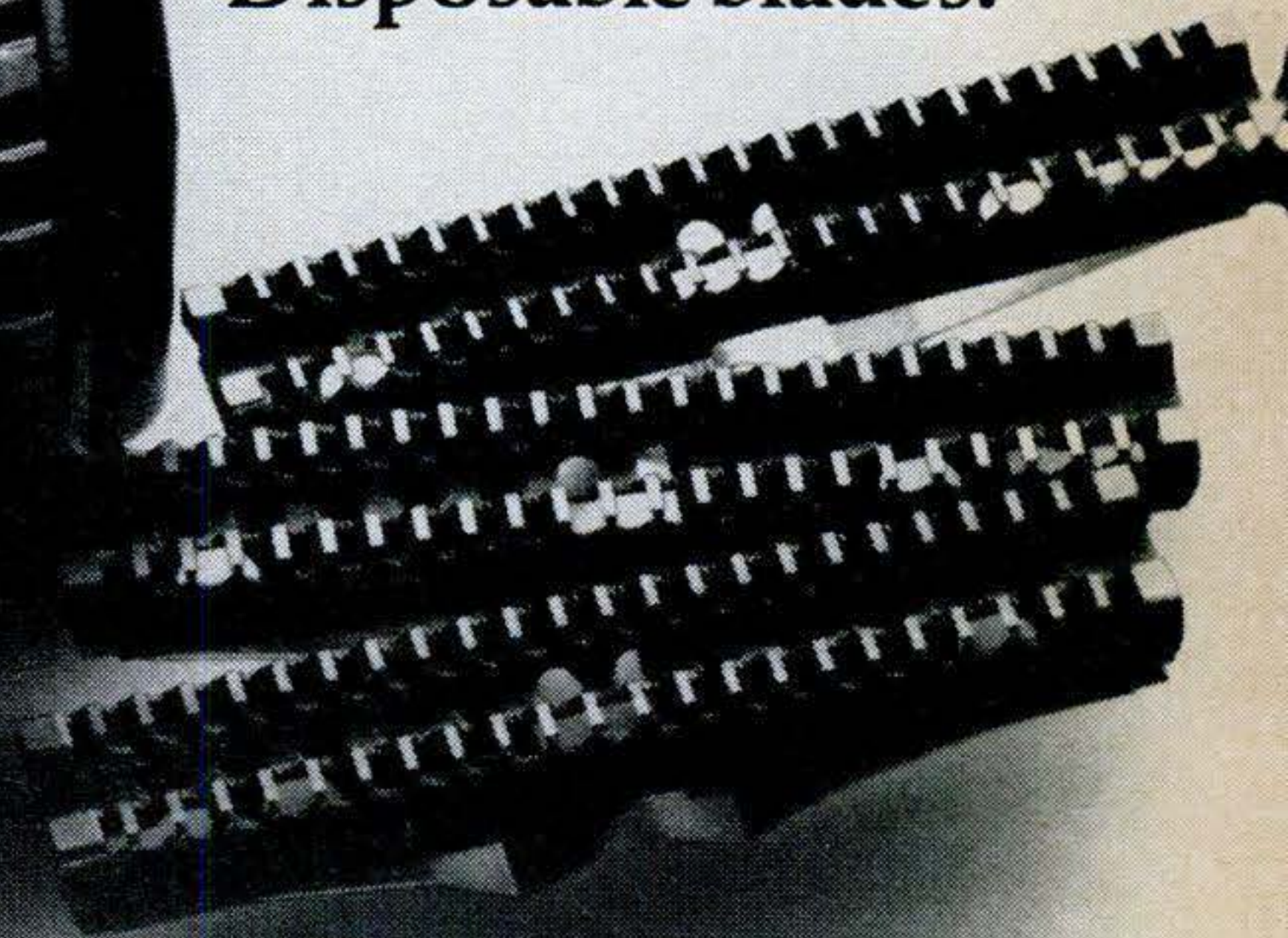
How to stop car thieves?

I disagree with William F. Ruck Jr., who says in Readers Talk Back (Sept.) that locking your car *will* stop a thief. The reason is that car manufacturers use so few lock combinations. Once while camping in Canada, I found an upset man whose boy had locked his car with the keys inside. My keys wouldn't fit the GM car, but after asking several other campers, we found a key which did fit. The same thing happened at Acadia National Park in Maine this year. A group of people were locked out of a car. My key didn't fit, but we



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the greatest idea in close,
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disposable blades.

Disposable blades.



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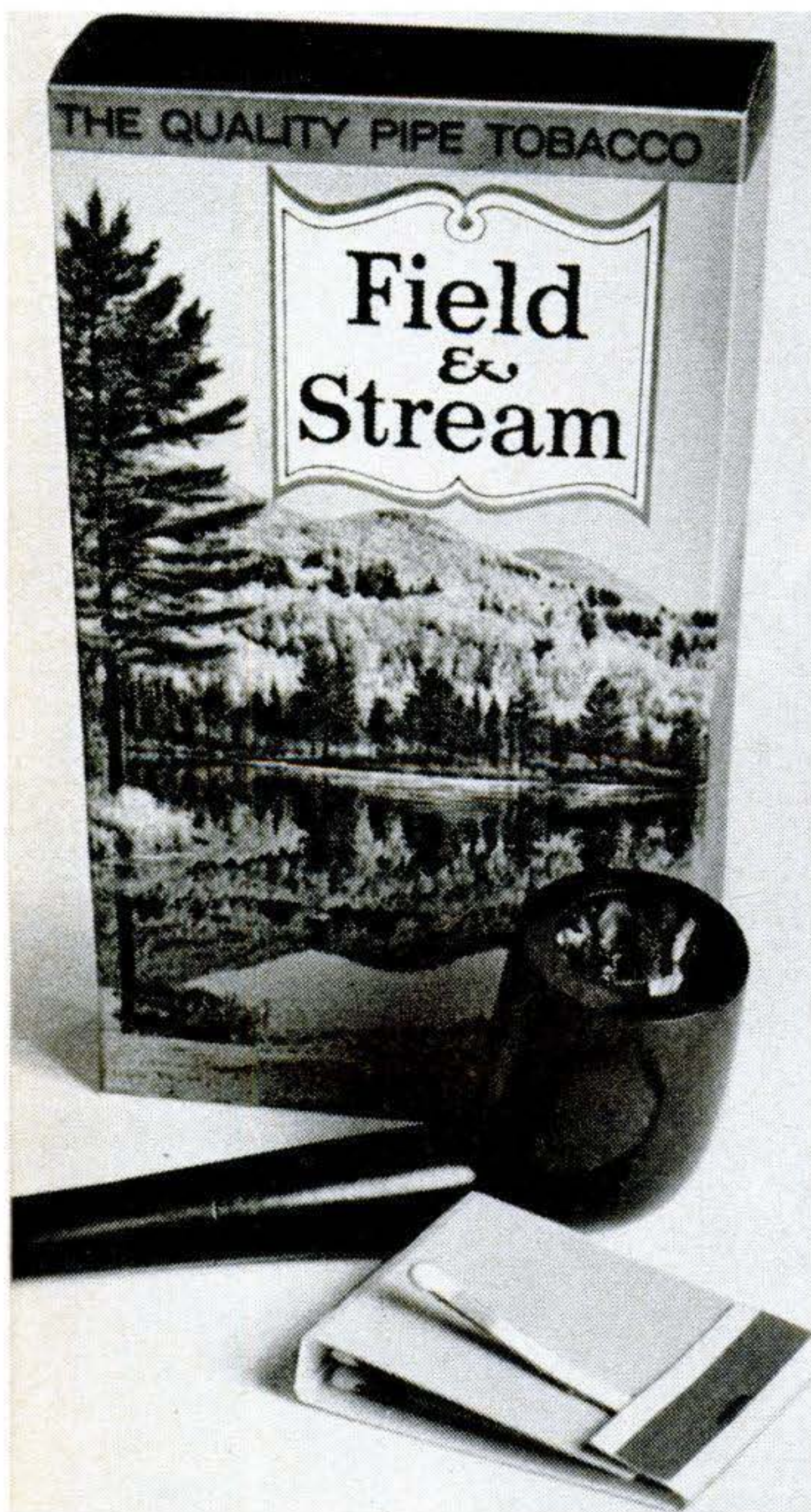
previous *Selectro* shavers. See dealer or write Box 435, Bridgeport, Conn. 06602. Enclose \$1.95 and we'll mail new blades.)

Our shavers with disposable blades might just make other shavers—disposable.

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of a great autumn
day in the woods...**



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PS Readers Talk Back

[Continued]

found a higher priced model in the same line as the locked car, asked the driver to try the key and it worked. It is so easy to take a fairly new car this way.

JAMES W. BURNS, Wakefield, Mass.

Big mirrors

You erred in "Wonder Glass Delights Cooks—and Astronomers" (Sept.) when you said that the 158-inch mirror for the Inter-American Observatory is the largest in the free world. The largest is the 200-inch mirror in the Hall telescope at the Palomar Observatory.

VINCENT CAPPUCCI III, Baltimore, Md.

The 158-inch mirror is the largest single-cast mirror in the free world. The 200-inch mirror in the Hall telescope was cast in several pieces.

Debugging an Apollo problem

On the first Apollo mission to the moon, the astronauts complained about dust particles floating around the capsule. Engineers apparently have not solved this problem, because on the second mission, the astronauts complained about glass-wool insulation floating around. What about a few sticks of good old-fashioned fly-paper suspended in strategic locations?

JACK H. HIRRLINGER, College Park, Md.



Four-cylinder bikes

Your article "Riding Honda's Fabulous Four" (Sept.) says that the Honda is the only four-cylinder motorcycle. The Clymer-Munch Mammoth, an 1,100 cc., four-cylinder bike made in Germany, is also available here.

GENE HOSLER, Tipp City, Ohio

National Air Races planes

I would like to correct Thorn Bacon's airplane identifications in "Comeback of the National Air Races" (Sept.). He calls the Bearcat an F85. It is actually the Grumman Bearcat, or F8F. He calls the Mustang a P-57, it's actually a P-51.

MRS. DONALD R. BOGER, Damascus, Md.

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ATTENTION CREDIT CARD HOLDERS: If you prefer, you may charge your Player and cartridges to one of your credit cards. We honor six different plans. Simply check your preference and include your account number on the coupon below.

[If coupon has been removed, write to Box B for full details.]

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Please enroll me as a member, and send me the Columbia 8-Track Cartridge Player described here. I am enclosing my check or money order for \$14.95. (Complete satisfaction is guaranteed or my money will be refunded in full.) Also send me these three cartridges, billing me \$6.98 each, plus mailing and handling for the Player and cartridges. Fill in numbers:

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320-8/5K

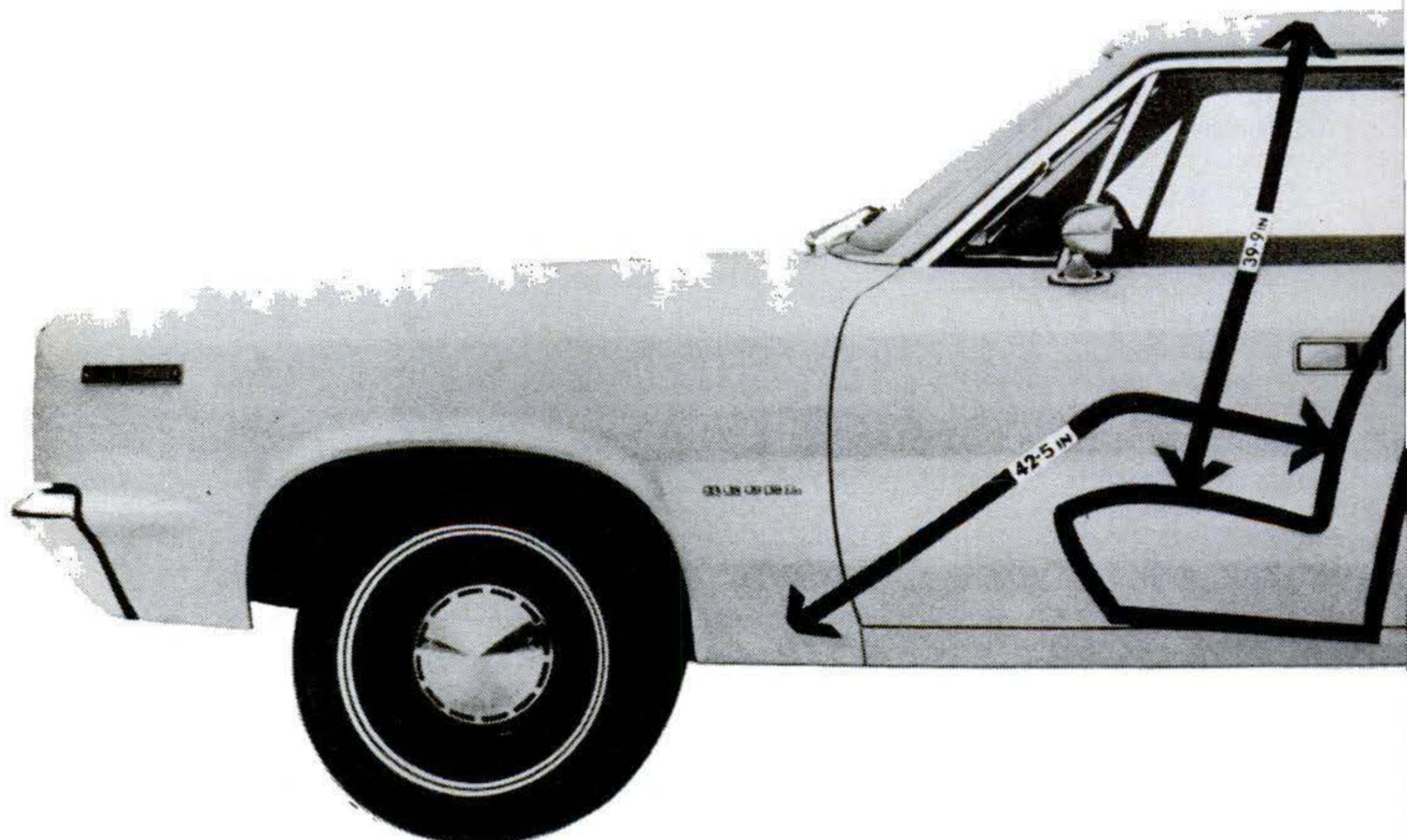
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Our Rebel Wagon has the lowest list price of any wagon made in America.

It also has more room inside than any other wagon in the intermediate class. (More room, for example,

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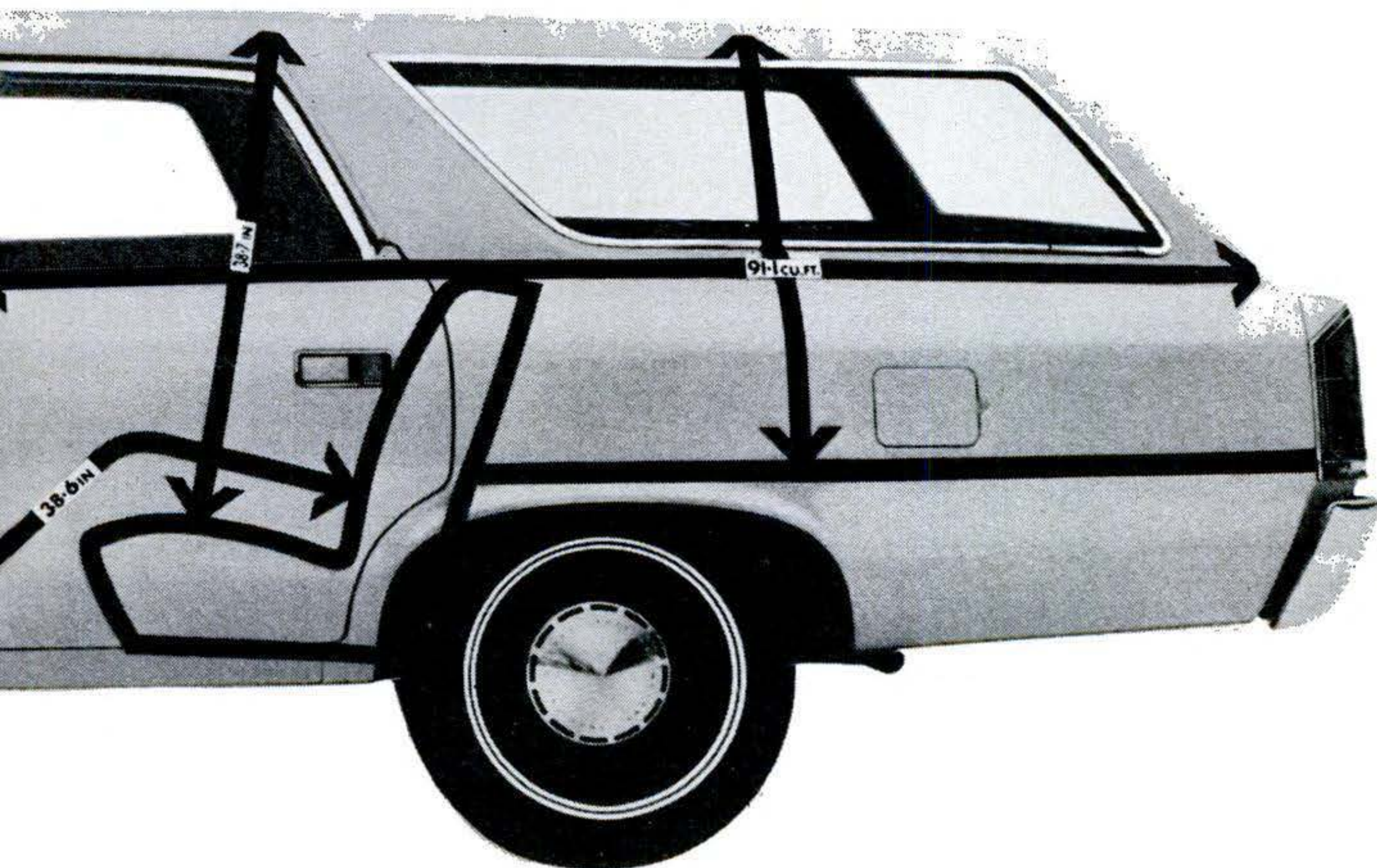
And you don't have to take our word for it.

We're displaying specially-marked Rebel Wagons so that you can see just what you get from us.

And, we're furnishing charts and tape measures so that you can go see just what you get from anybody else.

At the risk of being unfair, here's what you get in cargo space, which is what most people buy a wagon

or Plymouth salesman room priced at \$2,766.*



in the first place.

According to Automobile Manufacturer's Association figures, the Rebel gives you 91.1 cubic feet of above-the-floor cargo space. Fairlane gives you 87.0; Belvedere, 84.9 and Chevelle, 84.0.

So the Rebel is way ahead there. Now, about shoulder room, hip-room, legroom and headroom.

Against Fairlane and Chevelle, the Rebel wins in 7 out of 8 AMA interior measurements, (5 out of 8 against Belvedere), and it wins in

all the important places. Which leads us to think that you can't find more room for your money than you get in a Rebel Wagon.

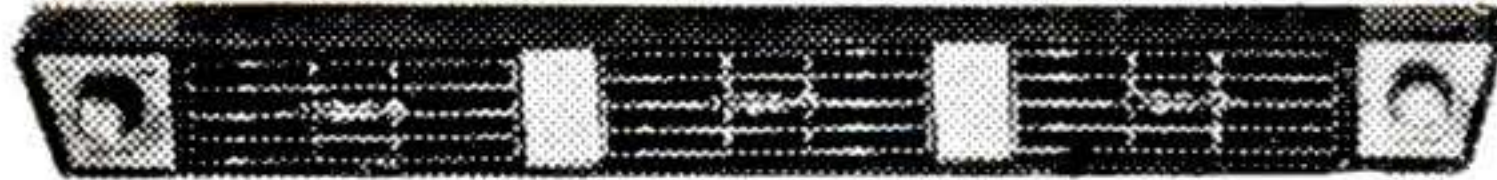
If we thought you could, we wouldn't be handing out charts and tape measures.

American Motors Rebel Wagon

*Manufacturer's suggested retail price for Rebel 4-Door station wagon, federal taxes included. State and local taxes, if any, destination charges, white wall tires and other options extra.

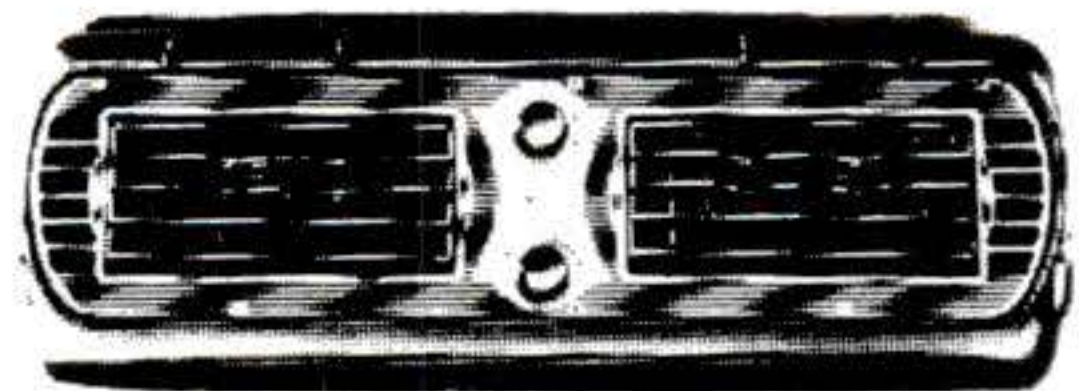
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☐ Ship so I will receive unit about.....
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I order. I enclose \$1.00 for instruction book only.
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My car is a.....(year).....(model).....

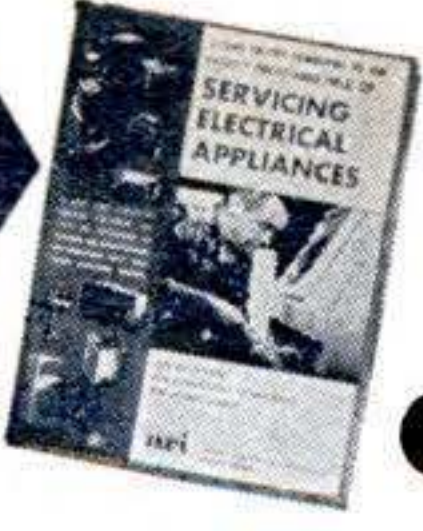
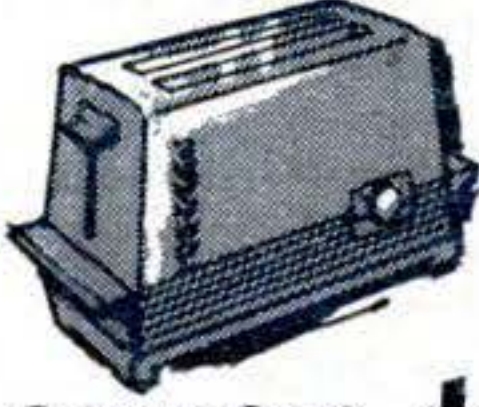
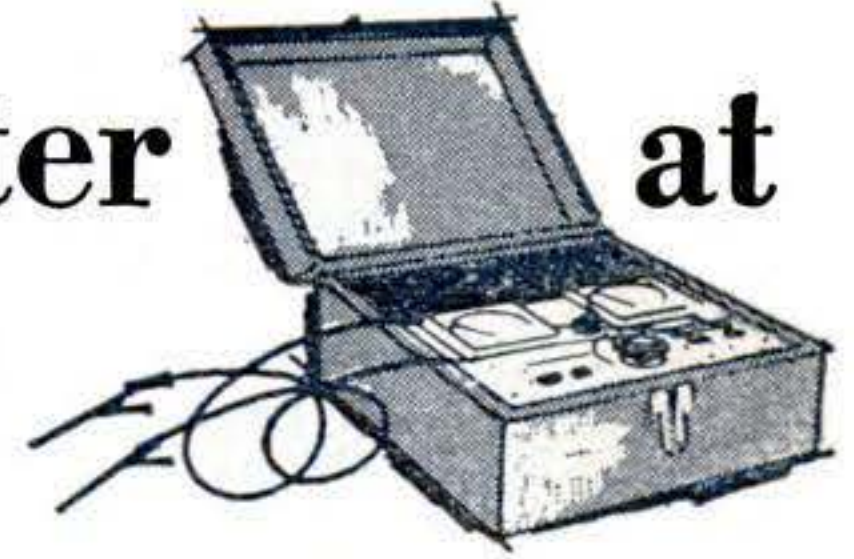
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"Say, Smokey—"

A clinic on cars by America's most famous mechanic

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Ask Smokey. You'll find the address at the end of the column. Please print your name and address.



Bunky Knudsen (far left) and Cale Yarborough take time out to enjoy Smokey's dry wit.

At speeds of over 30 miles an hour, the steering and whole front end of my '66 CJ-6 Jeep shakes. It has only 25,000 miles on it. We've had the idle arm replaced and the front end aligned; it doesn't help. What's the cause; how can we stop it?

RONALD PETERS, S.W. Margaree, N.S.

Your problem is quite simple. Have all the play taken out of the complete front-end suspension and steering system, and reset to specs. Any component of the systems mentioned, if loose, would give some reaction. As the wheels ride over the irregular surface of a road, contours that create a directional change for one, or both of them, tied into an incorrect setting (such as too much caster) will cause a violent shimmy. Try pushing a piece of furniture on caster wheels and see what those wheels do when they hit an irregular surface!

The steering is very slow on our 1968 Camaro 250-cu.-in. six with standard shift. Would power steering be a wise move, and would it affect performance and economy? The dealer has aligned and balanced the tires; still it steers extremely slow.

WILLIAM L. HEBERT, Westbrook, Me.

Get your dealer to check his parts list for high-performance options for the Camaro. They list a faster manual steering gear. You'll have to have a wide-awake dealer. A lot of dealers will tell you, "There ain't no such animal."

I have trouble with a knock in the 302 engine of my '68 Ford Galaxie that occurs whenever I accelerate. I tried low-grade gasoline with the carburetor set for it, and

it knocked. The same result followed using, and setting for, premium gas. The one exception has been that there is no knock on Ethyl. What next?

BURTON HANSEN, Sleepy Eye, Minn.

Seems to me you answered your own question—use nothing but Ethyl gas. There are other roads to take, but they could be very expensive, involving possible disassembly of the engine and some changes only an exceptionally knowledgeable mechanic could make for you.

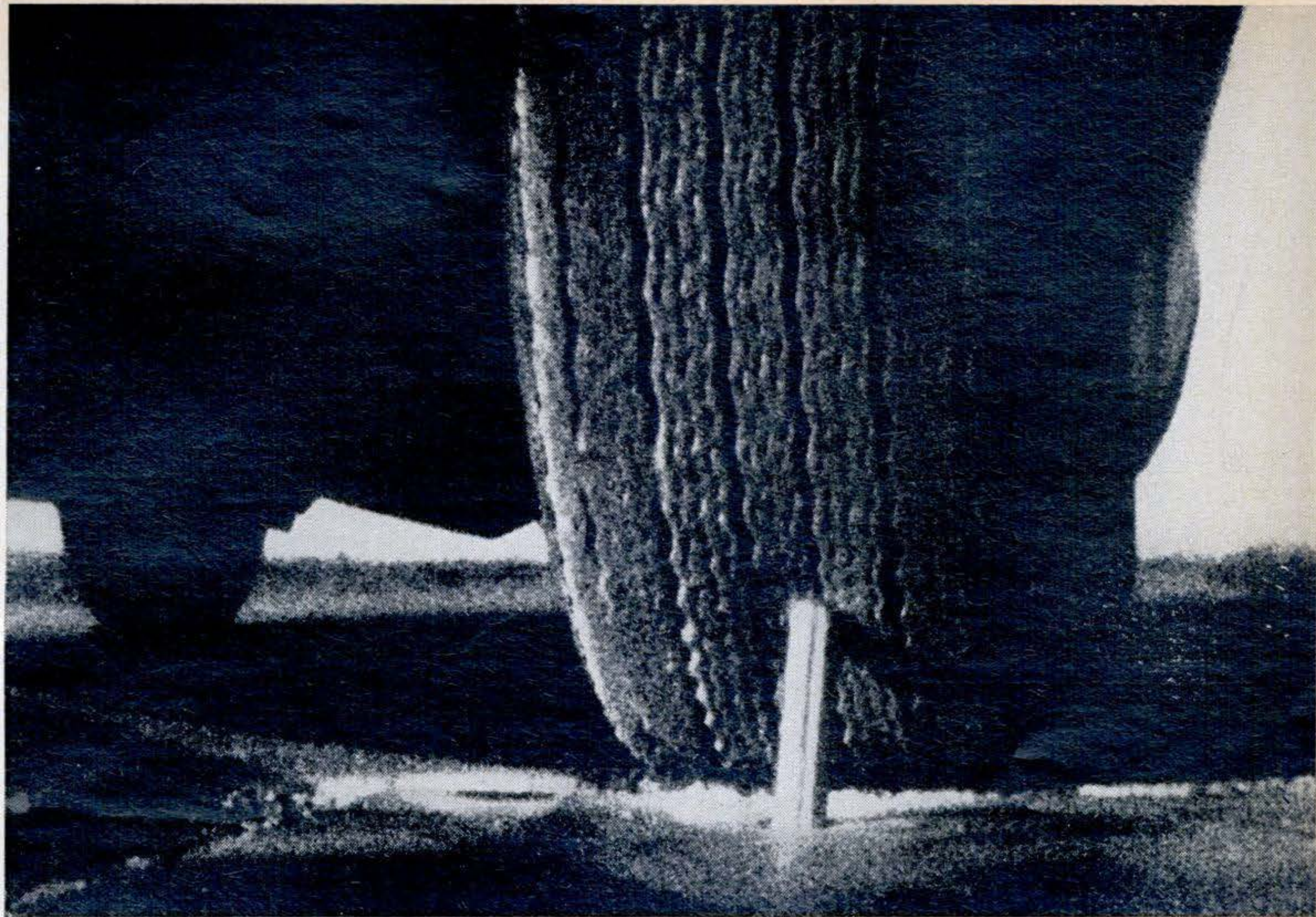
My '69 Dodge Coronet with 318-inch engine and automatic transmission ran fine until a few months ago. Now, once the engine is warm, it starts pinging. They can't find out what's wrong where I bought it. They say the timing is okay and it will ping on any gasoline. What can be done?

PHILLIP ECKS, Freehold, N.J.

Have the distributor-advance curve checked by numbers from idle all the way out. Then try different fuels one more time. If you still haven't helped the problem, try colder series-gap spark plugs. If the ping is still there, have the heads pulled and you'll find the trouble. It may be from a large carbon buildup, or from sharp edges in the combustion chamber or on the gaskets overhanging the chamber. But, aren't you aware of your warranty? If your dealer can't solve your problem, I'm sure that a sensible, descriptive letter of your trouble sent to Dodge will bring relief.

At freeway speeds my '67 VW bus is very difficult to keep on the road, especially in high winds. In fact, when a big truck goes

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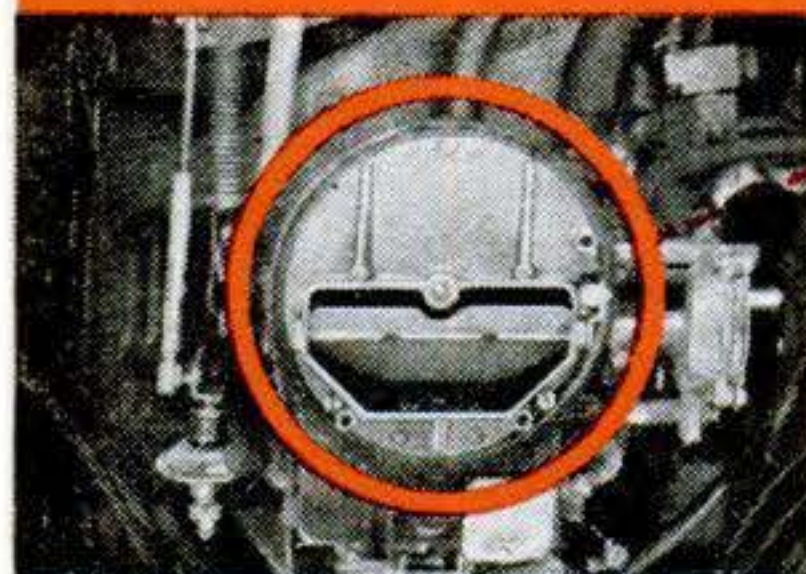


Photograph made by a special high-speed camera during an actual 60-mph test run over a 3½-inch steel rod, ¾-inch diameter.

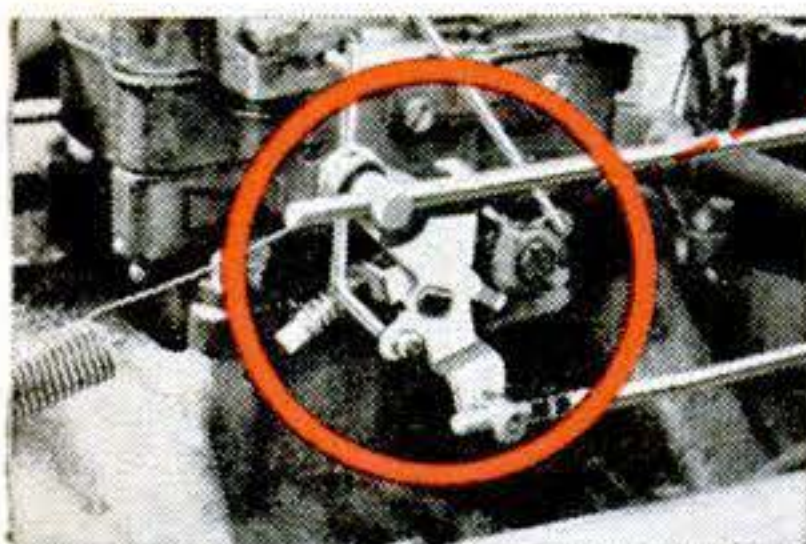
**This tire has 40,000 test miles on it.
But it can still survive this impact test.
The new Super Shell HP-40.
It can still take it when it's an old Super Shell HP-40.**



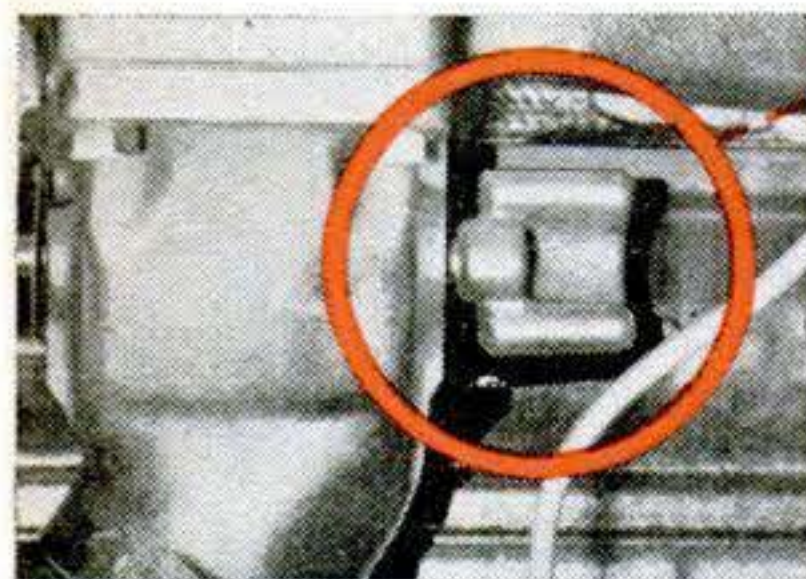
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"Say, Smokey—"

[Continued]

past, it just about blows my VW off the road. I have an Empi sway bar installed, but it doesn't help much. Do you think wider tires would help this condition?

DAVE L. GATES, Long Beach, Calif.

A VW bus is high and narrow and very unstable when subject to lateral forces, such as crosswinds. Heavier and wider tires, heavier shocks and springs, and sway bars will help some, but it is still too high and skinny to be driven fast when you must ride in a high wind.

I own a '68 Oldsmobile Cutlass that I can hardly stop from over 50 m.p.h. because of brake fade. This has been so ever since I bought the car new. I've had it back to the dealer repeatedly with no satisfaction. He finally told me that the brake linings were glazed, but he couldn't replace them, because they're not on warranty. I wrote to GM but still had no satisfaction. It looks to me like I'll have to replace them at my own expense, but what assurance do I have that the problem will not recur?

RICHARD S. CARTAINO, Emerson, N.J.

If you install a good premium lining such as Grey Rock or Raybestos, have the drums trued, with correct finish and the lining arched to match, and—most important—break in this lining correctly, you won't have this problem anymore. It is important during this process to have the brakes bled very thoroughly. It would take considerable space to cover proper lining break-in, but basically it involves fairly moderate use for 40 to 50 stops, to avoid getting the brakes very hot until the lining and drums are well mated.

I'd like to get more acceleration out of the 120-hp. six-cylinder engine in my new Maverick. Would a double-barrel carburetor make a significant improvement? How about economy?

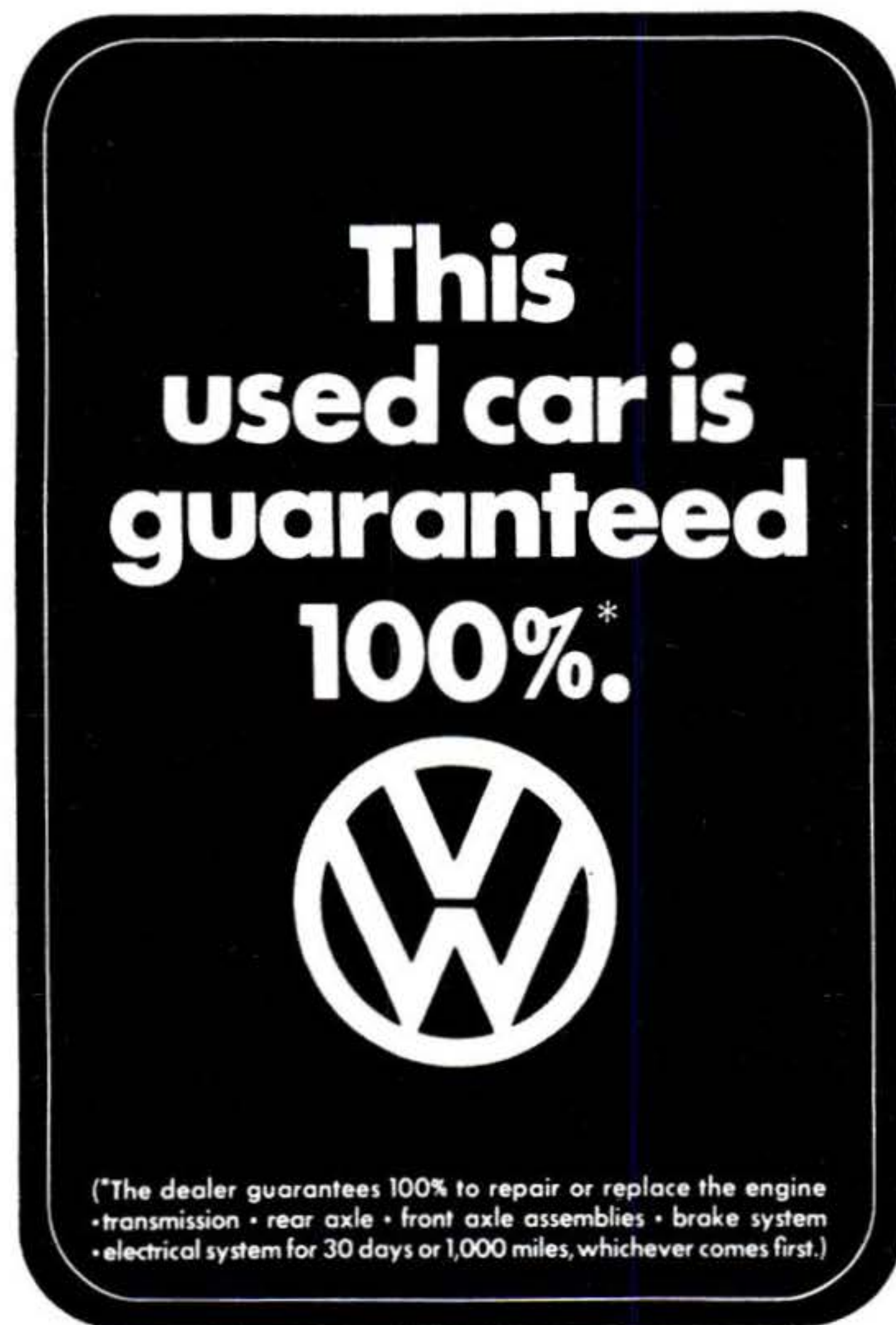
MICHAEL KLOCZKOWICZ, New York, N.Y.

You hardly gave that model time for the paint to dry, did you? If you insist on soup-ing it up, get the address of O. K. Miller in California from your local Ford dealer. Miller is the ace "heat-up" man on sixes. My solution would be to put the "Boss" 302 V-8 engine in that wild horse to have the hottest rod on the block. Economy? Forget it. Modified six or engine swap, economy will be long gone.

My GMC pickup sits in the garage for

Continued

35 reassuring words from your Volkswagen dealer.



(*The dealer guarantees 100% to repair or replace the engine
• transmission • rear axle • front axle assemblies • brake system
• electrical system for 30 days or 1,000 miles, whichever comes first.)

*This sign appears only in cars selected by your VW dealer.

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ADDRESS _____

"Say, Smokey—"

[Continued]

two weeks to a month, without being started. Naturally, the oil drains down from all the parts and cylinder walls. When I do start it, it runs on a dry engine for several seconds before the oil rises. This has tended to wear the pistons, much more so than has the actual mileage. Is it possible to install a small but efficient auxiliary oil pump in the line to work from a separate switch before starting? If not, what do you suggest?

MILTON I. WAIDLEY, Oakland, Calif.

There's no practical way I know to carry out your plan. But try this: Install a separate starter switch to turn the engine over until the oil pressure rises, then turn on the ignition. Or failing that, try starting and stopping until the pressure rises before leaving the ignition turned on.

I am considering buying a Porsche 911, but I have heard many remarks on their engine problems. Many owners have reported burned pistons and fouled plugs. What is wrong? Is this true only for early models of the Porsche? And is there any practical solution?

MARK CLARK, Huntsville, Ala.

Driven like a road car, Porsche I think does a good job, and is not subject to a lot of engine failure or maintenance. Drive it as if you are in a race all the time and you'll have your problems; more so in earlier models. If you plan on race-type driving, then for my money you should buy some American car with a ferocious-animal name. It will go faster, for a longer period, and be cheaper in the end.

You gave your opinion of STP in June. If Granatelli hasn't had you taken care of by now, how about sticking your neck out again and giving your opinion on another additive — Rislone? Also, what additives did you use in your Indy 500 car?

JIM REDBURN, Norwalk, Calif.

I've got enough neck left to stick out and say that I feel the same way about all oil additives. They are not necessary in sound engines, as long as a good and correct type of motor oil is used. As for my Indy 500 car—I had a can of STP in it, for which I got \$3,000 in prize money.

Got a question on autos? Send it to:

"Say, Smokey—" POPULAR SCIENCE

355 Lexington Ave., New York, N.Y. 10017.

Not every question may be used. Questions cannot be answered by individual letters.

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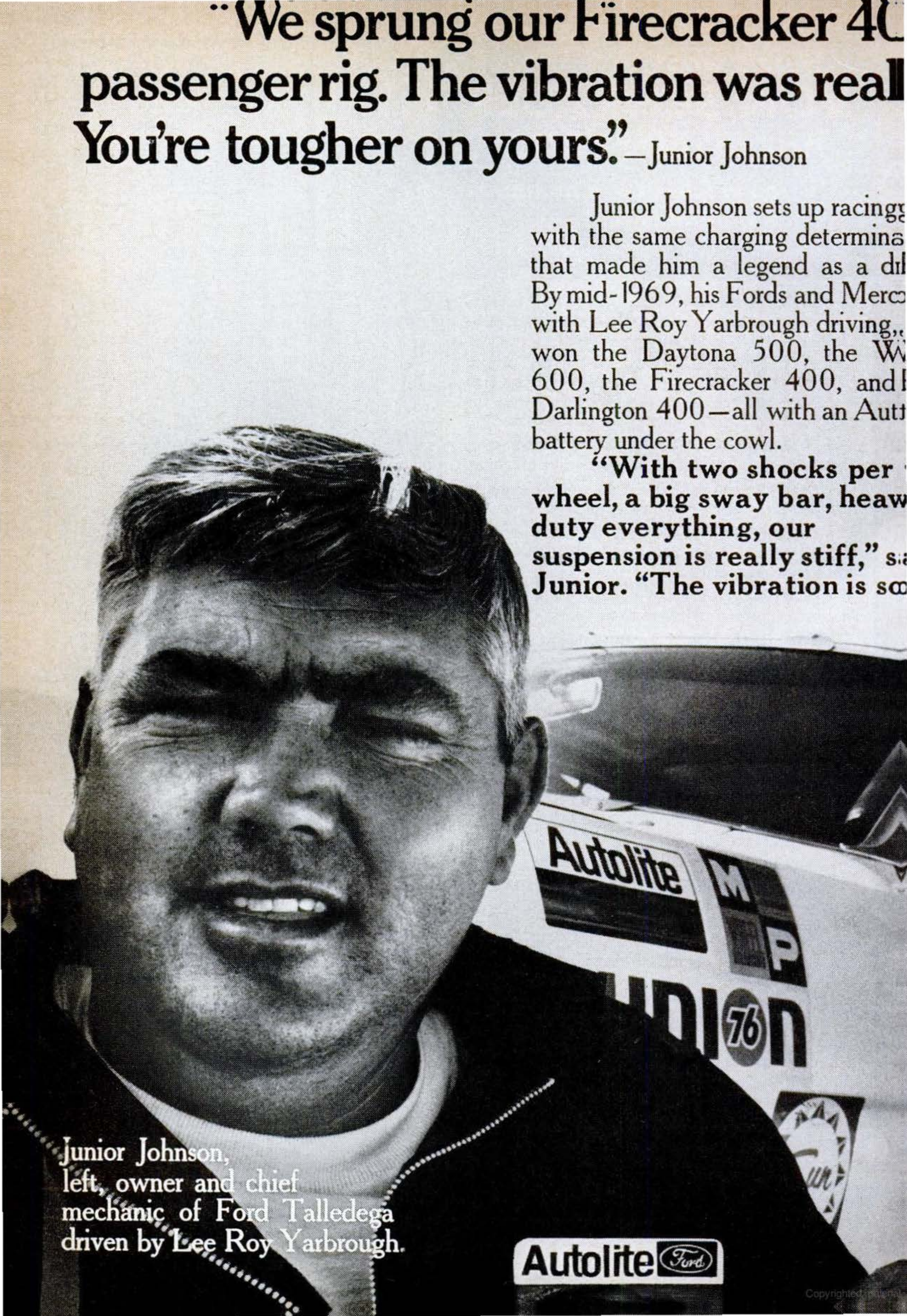
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NOVEMBER 1969 | 19

"We sprung our Firecracker 400 passenger rig. The vibration was real. You're tougher on yours."—Junior Johnson

Junior Johnson sets up racing with the same charging determination that made him a legend as a driver. By mid-1969, his Fords and Mercs, with Lee Roy Yarbrough driving, won the Daytona 500, the Winston 600, the Firecracker 400, and the Darlington 400—all with an Autolite battery under the cowl.

"With two shocks per wheel, a big sway bar, heavy-duty everything, our suspension is really stiff," says Junior. "The vibration is so



Junior Johnson, left, owner and chief mechanic of Ford Talledega driven by Lee Roy Yarbrough.

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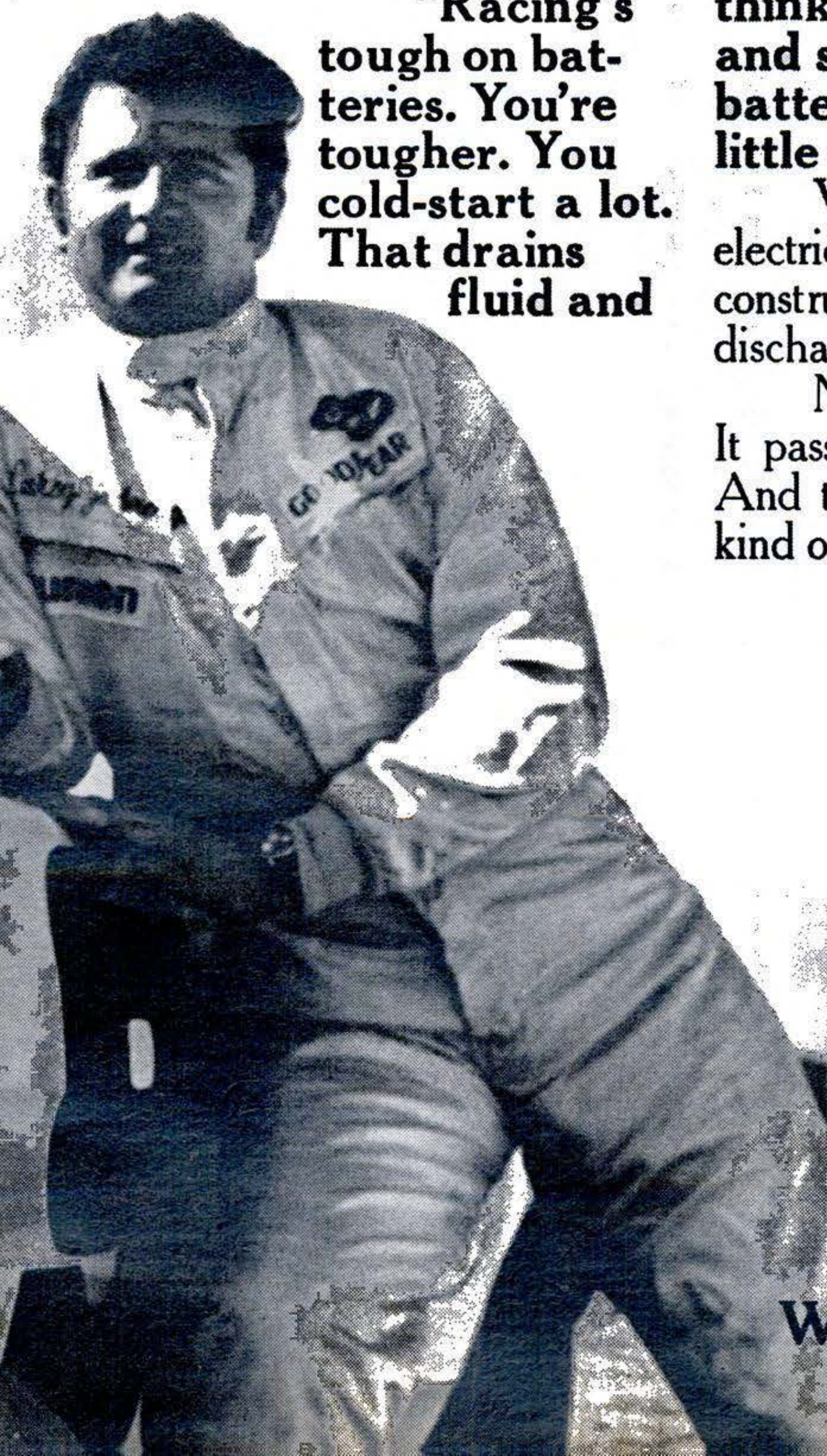
power. And then you don't let
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That's okay with Autolite. Its
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It passes the toughest test in racing.
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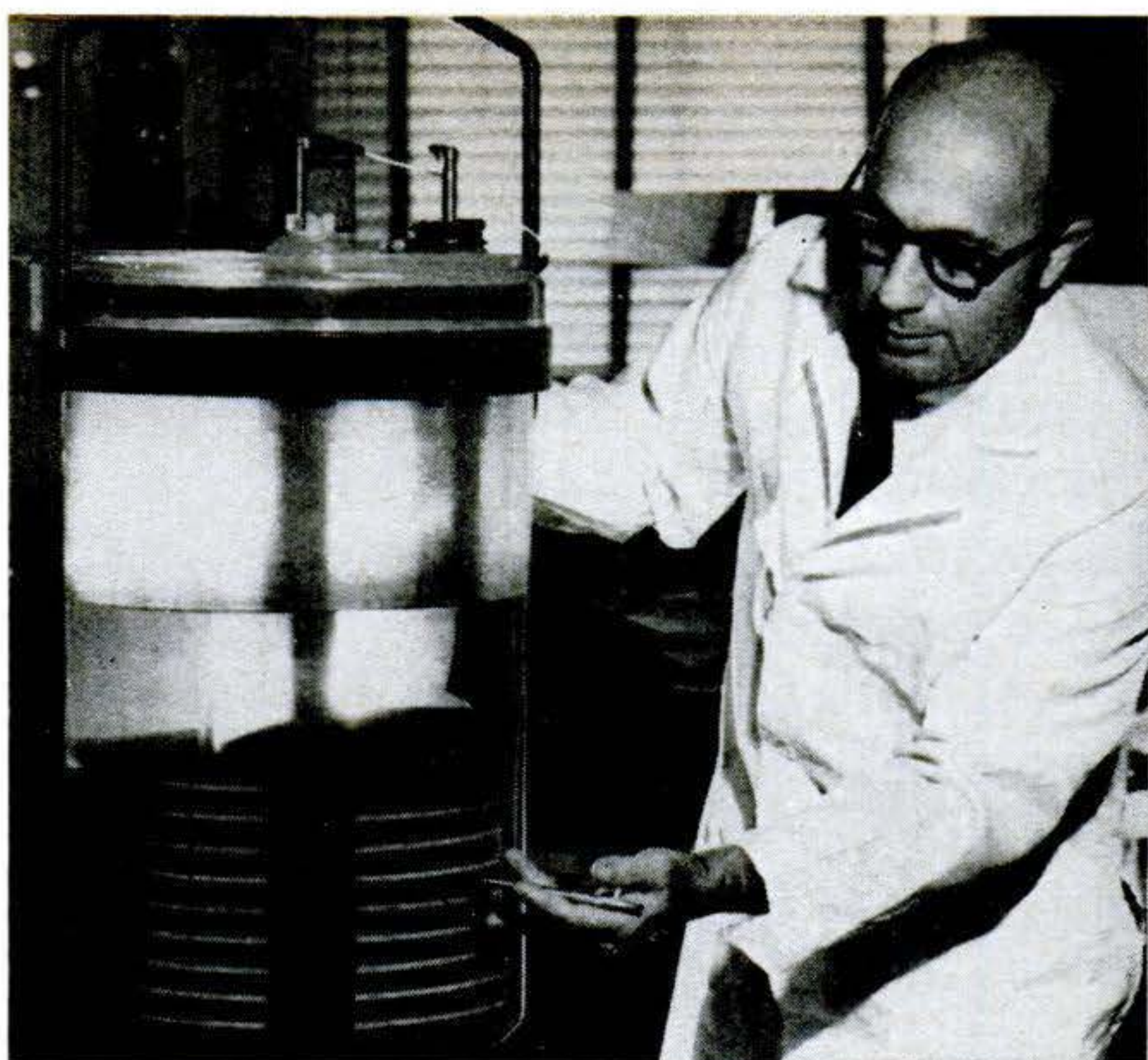
We pass the toughest test.

Science Newsfront

Last-minute news
and notes to keep you
up-to-date

By ARTHUR FISHER

A new lead-acid battery from Bell Telephone Laboratories actually boosts its capacity with age and will run for 30 years—double the usual life—at no increase in weight or volume. Its cylindrical shape is stronger than a rectangular one, so circular grids of soft, pure lead replace stronger, but faster corroding lead alloys. An improved energy-producing



paste combines with the grids for longer-lasting and more efficient plates. Bell will use the batteries during power failures, but the unique design could wind up improving your auto battery.

New computer-driven postal machinery will speed up the processing of mail that is properly addressed with zip code, but may possibly delay mail that lacks the zip code. The new, zippier system will work like this: Machine flashes letter to postal clerk, who reads address, punches button that tells machine what the zip code is; computer remembers which of 277 bins corresponds to that code, and zips letter along accordingly. But woe betide a letter that lacks the zip code! For unzipped mail, the clerk punches a button that shunts the letter aside for later processing by hand. If this makes your letter miss the next Pony Express rider, the delay might be considerable.

Martian mysteries continue to tantalize scientists. Our two Mars probes, Mariner 6 and Mariner 7, provided astronomers with a rich diet of goodies in the form of new data, which computers have been digesting ever since August. The Mariner photos showed large areas of the red planet to have a much-cratered surface strikingly like that of the moon. Now the computers have clarified some previously undecipherable closeups taken by Mariner 6.

These pictures reveal, in the bright region west of the Sinus Meridiani, a totally unexpected Marscape of confused terrain that

is like nothing man has seen on Earth, moon, or Mars before. For hundreds of thousands of square miles, precipitous hills and valleys are jumbled together without pattern. And to add to the mystery, this puzzling region is some two degrees warmer than the surrounding area, whereas it should, logically speaking, be cooler.

An ultra-short-takeoff-and-landing plane has been certified by the Federal Aviation Administration. The Helio Stallion is the fastest and largest STOL aircraft to be built in the United States: It will whisk away eight to 11 passengers at a cruising speed of 217 m.p.h. And the Helio Stallion can take off fully loaded in a mere 320 feet, under no-wind conditions. It has special features that permit it to take off and make fast turns even in gusty winds, and to maneuver at a positive crawl—42 m.p.h.

Air pollution in outer space? That's right, and NASA wants to put a stop to it. The space agency has requested the Lockheed Missiles & Space Co. to develop a method for controlling trace contaminants inside a spacecraft. These gases—150 of them have been found to pollute spacecraft atmospheres—arise from the many materials inside the craft, and from the men themselves. Some of the more toxic

Continued



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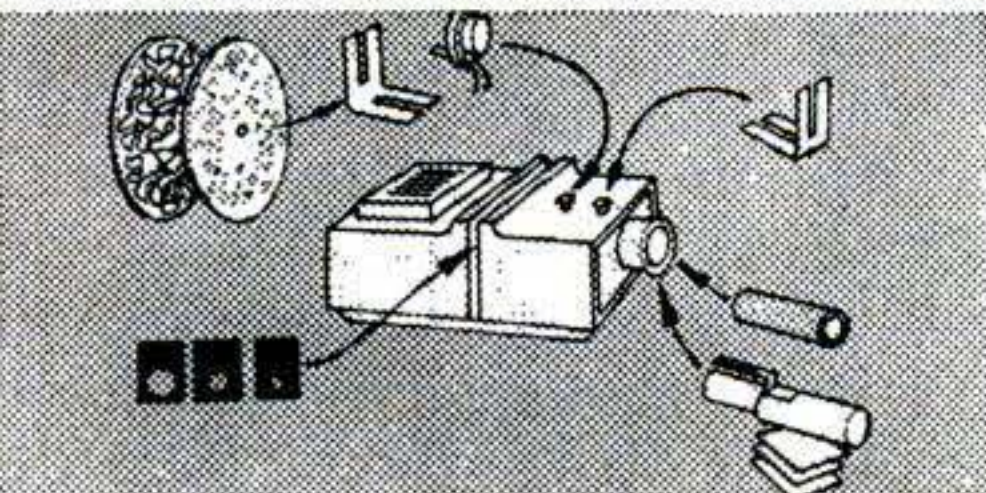
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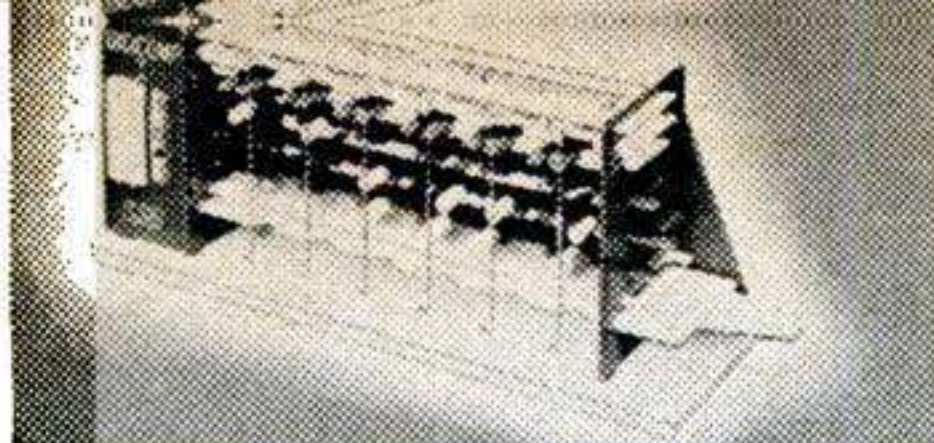
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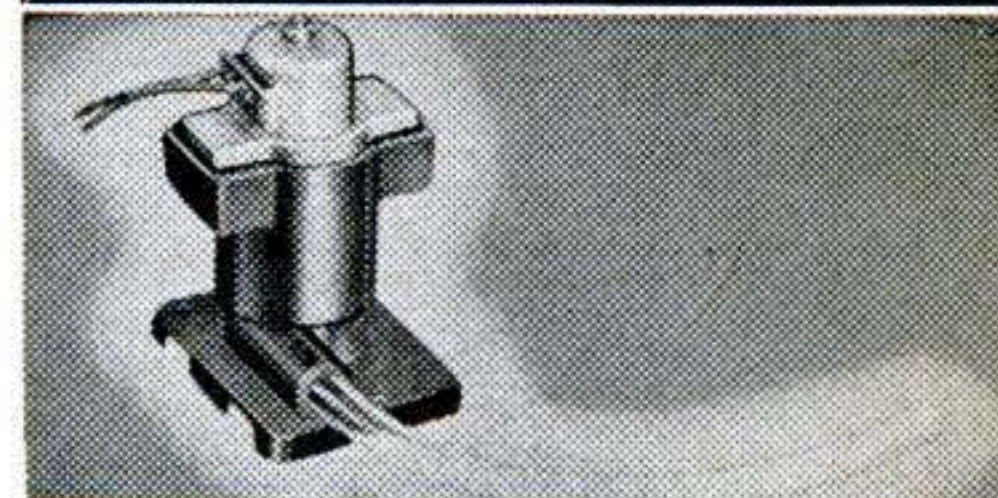
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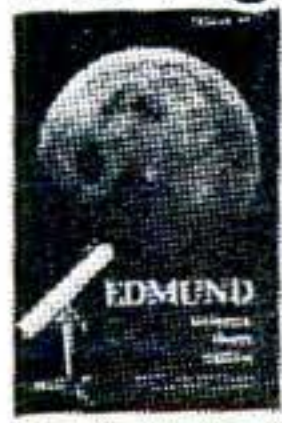
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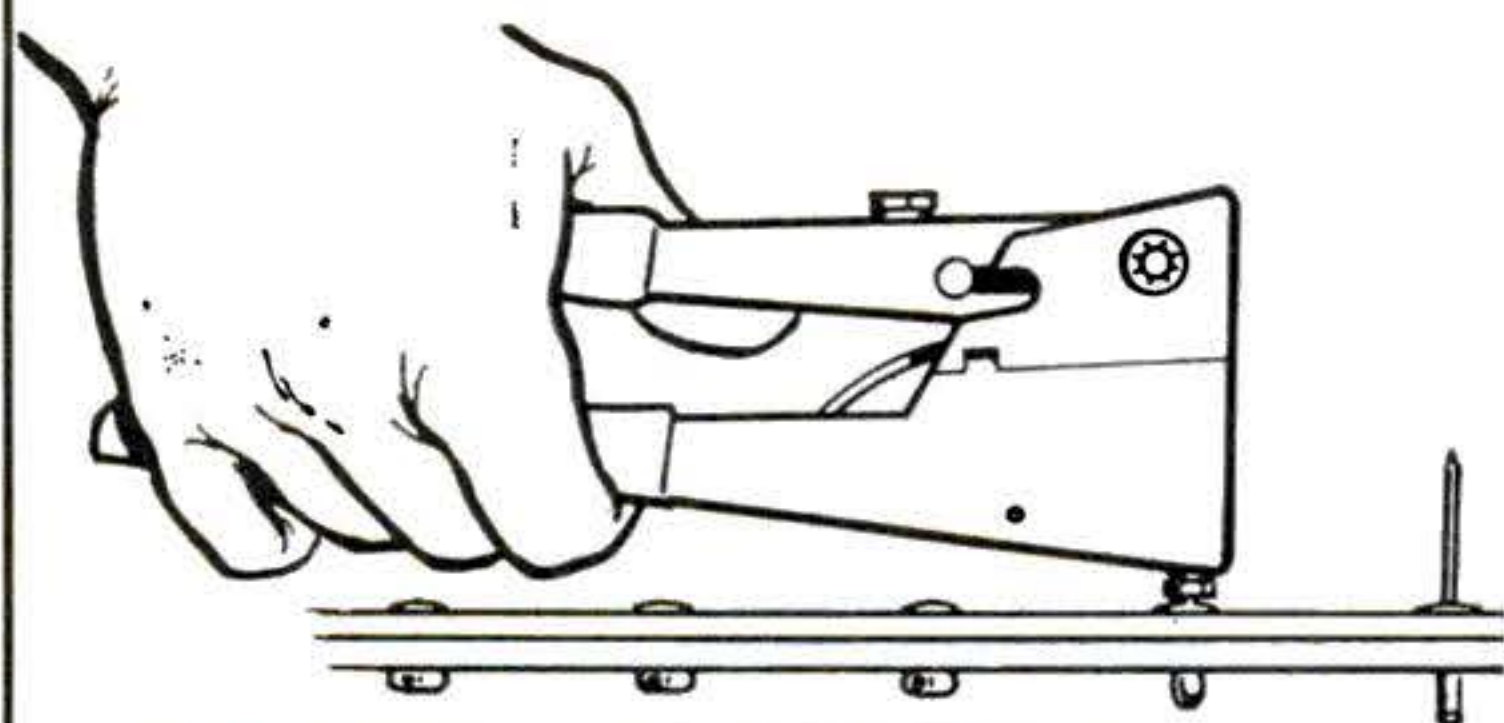
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Science Newsfront [Continued]

ones are carbon monoxide, methane, and ammonia—all must be controlled or eliminated. Unlike the Earth's atmosphere, the air inside a moonship doesn't get cleaned by rains or winds. NASA has called for a filter to remove or reduce the contaminants; Lockheed will choose the filter material—possibly a new "super" activated charcoal—build it into a device, and figure out a way to regenerate it after it becomes clogged.

A unique oceanographic vessel that can recover 200-ton loads from depths of more than a mile—without submerging—will be built for Alcoa. Dubbed the Seaprobe, the all-aluminum ship will be the largest deep-ocean search and recovery craft ever designed: 244 feet long, with a 50-foot beam and 2,000-ton displacement.

Diesel-electric generators will give the Seaprobe a 10,000-mile, 45-day cruising range. It will mount a derrick capable of lowering a 6,000-foot string of pipe to the ocean floor, and will be able to hold its position in rough seas. Special devices will enable it not only to search, core, and sample mineral deposits on the sea bed, but to locate and retrieve heavy objects; it will be made available for emergency underwater operations. Sea trials are expected early in 1971.

Getting rid of garbage is one of the peskiest problems of modern society. Most current methods are costly, impractical, and pollute the environment. Now, six Swedish scientists have come up with a scheme that not only disposes of garbage but fights pollution and increases the fuel supply simultaneously. The plan, developed at the Institute for Chemical Technology in Stockholm, would produce fuel by burning waste in furnaces.

The resulting flue gases include hydrochloric acid and carbon dioxide. The acid would be neutralized with calcium or washed away with water, and the carbon dioxide would be combined with hydrogen to yield methanol, a useful fuel. Although the initial investment would be high (about ¾ billion dollars for Sweden) the system would eventually prove cheaper than present garbage disposal methods because of methanol sales.

A breakthrough in laser power may be nigh. Sylvania Electric Products has a new 1,000-watt carbon dioxide continuous-wave laser that is as big as an office desk, rather than the locomotive size typical of this power output until now. The device, called a "gas-transport laser," saves space by using a closed-cycle gas-cooling system that dissipates the high internal heat generated by high-power

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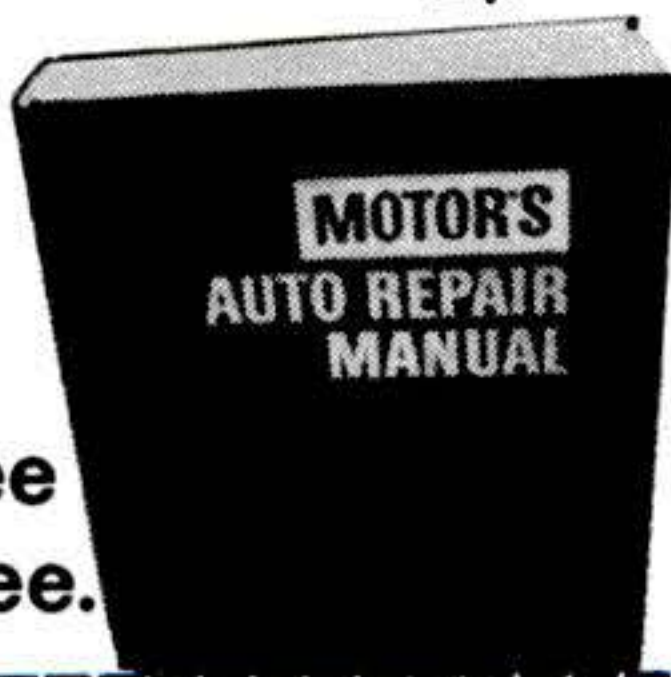
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Science Newsfront

[Continued]

lasers of conventional design. Sylvania engineers believe the new technique can be applied to other kinds of gas lasers.

Hark, hark, the quark! An Australian physicist claims that he has actually found a *quark*, until now a whimsically named, completely theoretical particle that is—if it really exists—the smallest particle of matter. Prof. Charles McCusker of the University of Sydney says he is "99 percent sure" of his identification, but many of his colleagues believe further confirmation is necessary. They are all excited, at any rate, because the discovery could put us on the threshold of fantastic new energy sources.

Don't build your house on clay. That's the conclusion of a specialist in soil mechanics who has been studying the Leaning Tower of Pisa. Raymond J. Krizek of Northwestern University notes that one major reason for the Tower's breathless tilt is that it was built on very compressible clay soil and has been squeezing the water out of the clay for 800 years. Your house probably isn't heavy enough to do that. But clay under it could gain or lose moisture. For example, a tree nearby could be lapping up water, or a hot-air furnace could be drying out the soil under a crawl space, or a defective drain could be leaking water. Result: the clay swells or shrinks, the house rises or falls, and walls or foundations crack.

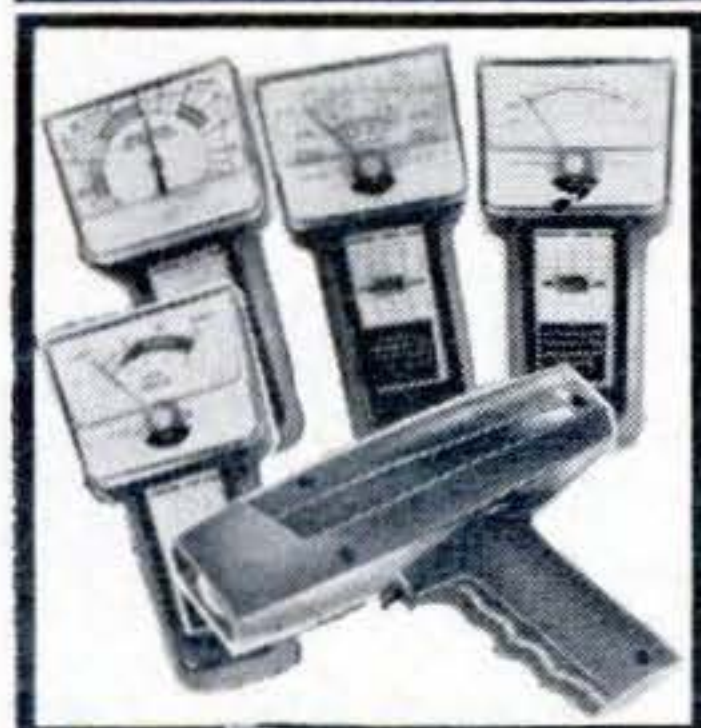
A computer is "whittling" model ship hulls. The scale models are being produced by the ship section of Canada's National Research Council in Ottawa to test the behavior of new hull designs. The dimensions of an experimental hull are first fed into a small computer, which governs a completely automatic milling machine. The machine carves the miniature hull out of a block of laminated wood. After sanding and shellacking, the hull is launched in a test tank, where it is put through maneuvers that tell engineers how full-scale models will handle.

A new survival radio for the Navy will enable specially equipped search planes to pinpoint a downed pilot's location within a tenth of a mile. According to the Honeywell Communications Center, which will produce the prototype, the radio will be the first military unit to provide distance measuring; present radios can yield only direction—not distance—to a pilot in distress. Range for distance measuring is about 82 nautical miles, for voice and direction finding about 120 miles. Length of the radio is a mere six inches. **P5**



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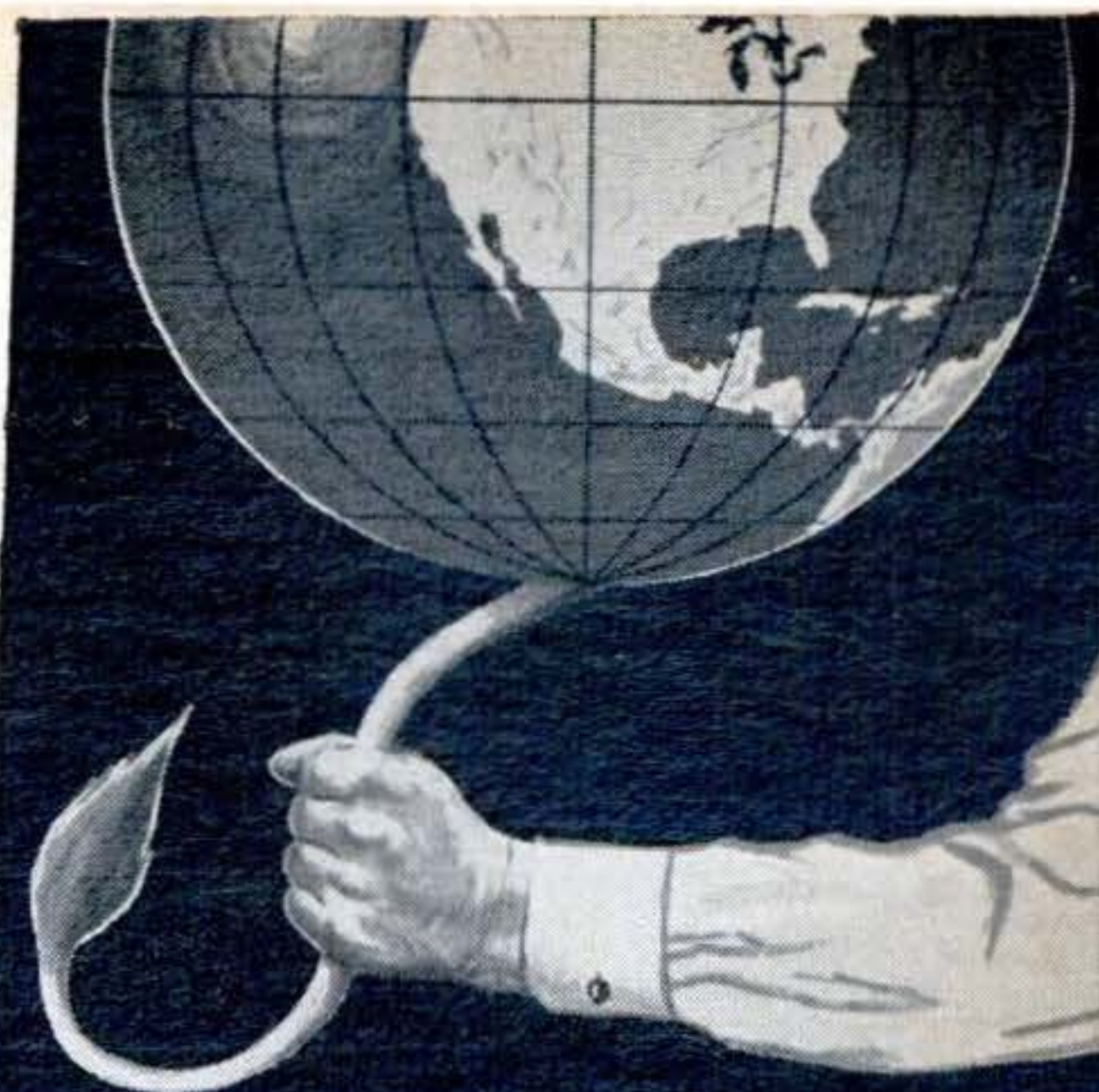
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Detroit Report...

WHO HAS THE BEST WARRANTY RECORD AT GENERAL MOTORS? Oldsmobile, according to GM insiders. Olds spends \$30 per car in warranty claims--lowest amount of any GM line. But this figure will rise as the remainder of five-year, 50,000-mile warranties is used up on older cars. Ten years ago Olds spent about \$20 per car in warranty costs. The rise is caused as much by the price increase of parts and labor as by added coverage of "5-and-50" warranties.

Chrysler's "25 car," the company's proposed mini-compact, comes in two versions; one for Dodge, the other for Plymouth. It will have a "full range of options," including power brakes, steering, and air conditioning. Chrysler says the car will debut in the summer of 1971, almost a year behind the rest of the new mini-compacts. It will be an all-American vehicle in style and mechanical parts, and Chrysler plans to build it in U.S. and Canada. Chrysler released dimension figures showing how the new mini-compacts will compare:

	25 car	XP 887	Special Maverick	AM's Gremlin
Wheelbase	91"	97"	94"	98"
Length:	166"	169"	160.8"	161"
Width:	71.6"	65"	66"	68"

Ford's Phoenix mini-compact will have a German-made engine when it debuts late next year. Now called by the code name, "Special Maverick," the car will use a four-cylinder engine based on the Ford Escort design. Escort engines are made in England, but Ford image-builders want the hallmark of German quality in the car, so a new engine-building line will be set up in Germany to produce for the American market. The Escort is smaller than GM's XP887 engine—120 cu. in. vs. 140 cu. in.—but has a great reputation in Europe.

Ford backed off from saying the 1971 Mercury Marquis would have safety air bags as standard equipment. While top sources inside the company said the bags were in the 1971 schedule, Ford officials in Washington told the government that the bag might not be ready in time. Ford claims that more testing is necessary. But one brave Ford engineer did his own testing—by experiencing two 30 mile-an-hour barrier crashes with the bag—and is firmly convinced they will save lives. He's fighting to get the bags in the cars; others in the company are more cautious. Chrysler safety experts are even more

cautious, say it will be "five or six years" before the air bags will go in Chryslers.

One basic suspension for each size of GM car? Yes. The move begins with the 1971 B- and C-body cars. That means the big Chevrolets, Pontiacs, Buicks, Oldsmobiles, and Cadillacs will have exactly the same front-suspension members. Only the spring rates and shock-absorber settings will be different for each separate car. Later, all GM cars of a size will have identical suspension parts as the company moves to standardize as much as possible. Biggest loss: Buick's Tru-Track front suspension, new last year. It provides directional stability plus sure response.

If you had your choice, which cars would you own? Chevrolet chief, John DeLorean, has a Blazer, Corvette, four-door Caprice, and Malibu at his house. His wife likes the Blazer best because it puts a lot of the fun of driving back into those long, flat Midwestern roads. They also like the high-up seating that gives good view in traffic, and the Blazer's off-road potential. Caprice is used mostly for carrying extra passengers on more formal occasions. DeLorean leans heavily toward European cars for evaluation purposes, especially a midship-engine Lamborghini Miura and the four-door Mercedes. A tipoff to what Chevy is planning in future models?

"Because it is the best tire in the world." That's the explanation given by a top Ford engineer when asked why the Lincoln Mark III has the Michelin radials as standard equipment on the 1970 models. But, surprisingly, car engineers expect little more tread mileage from the steel-belted Michelins than from the new bias/belted fiberglass tires.


Detroit Editor

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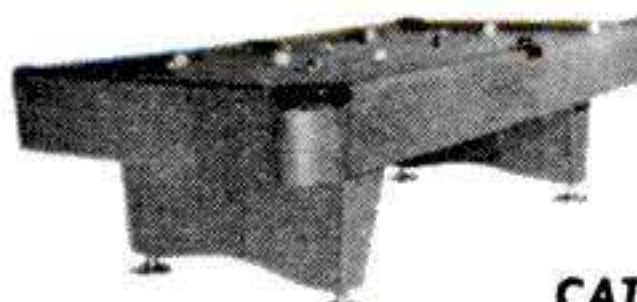
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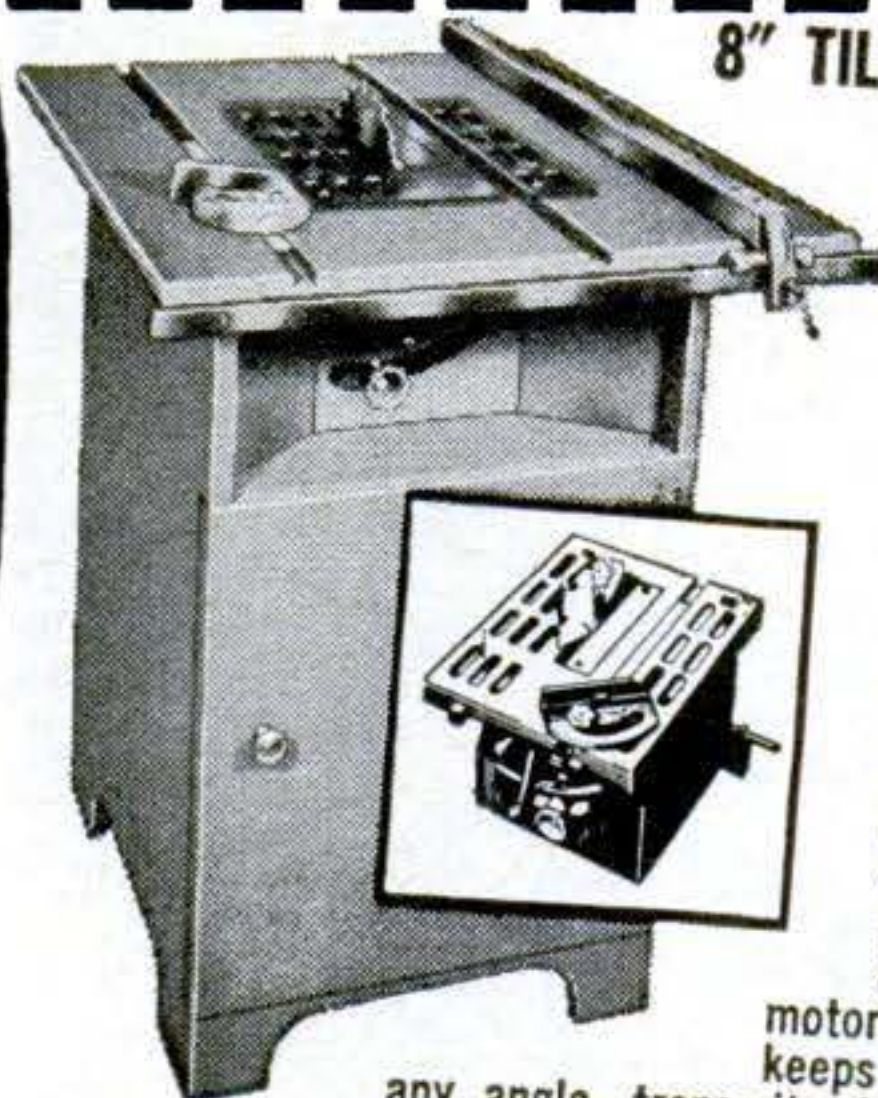
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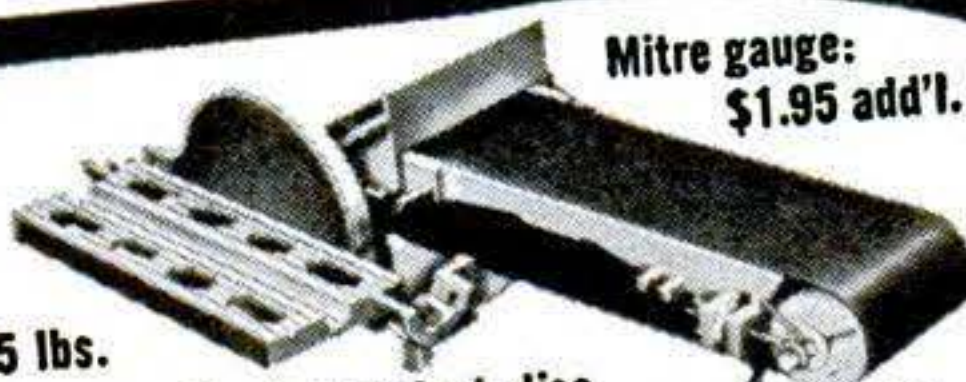
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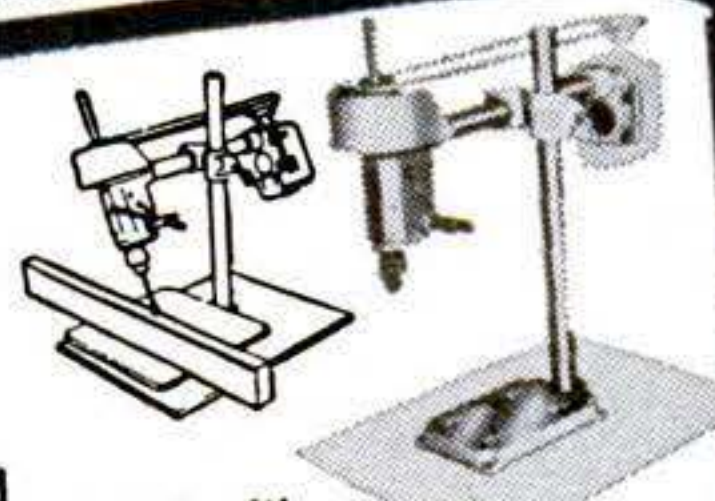
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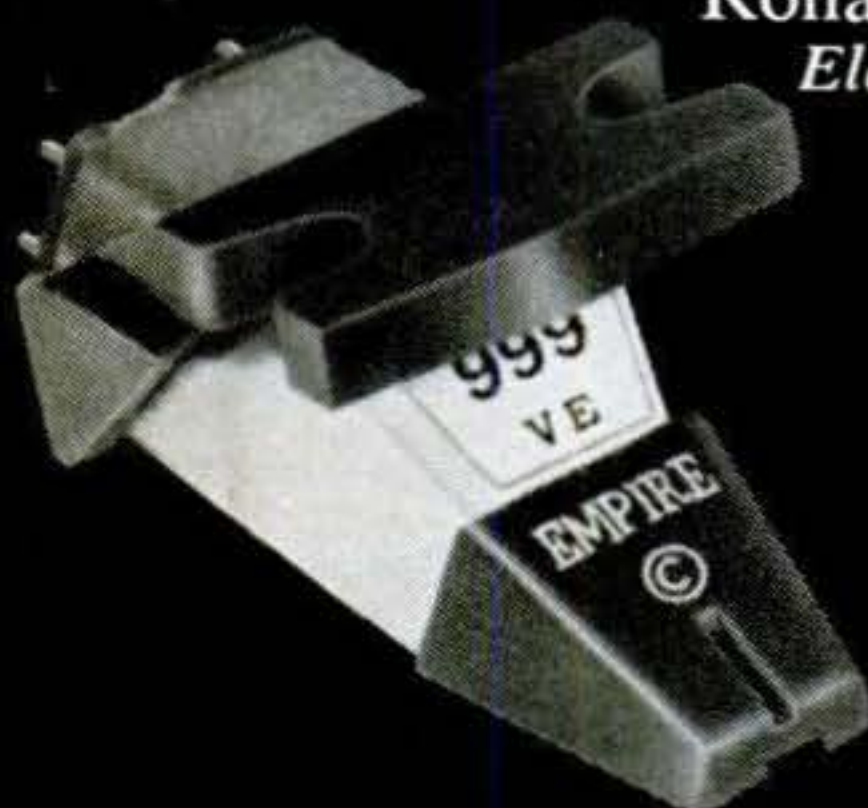
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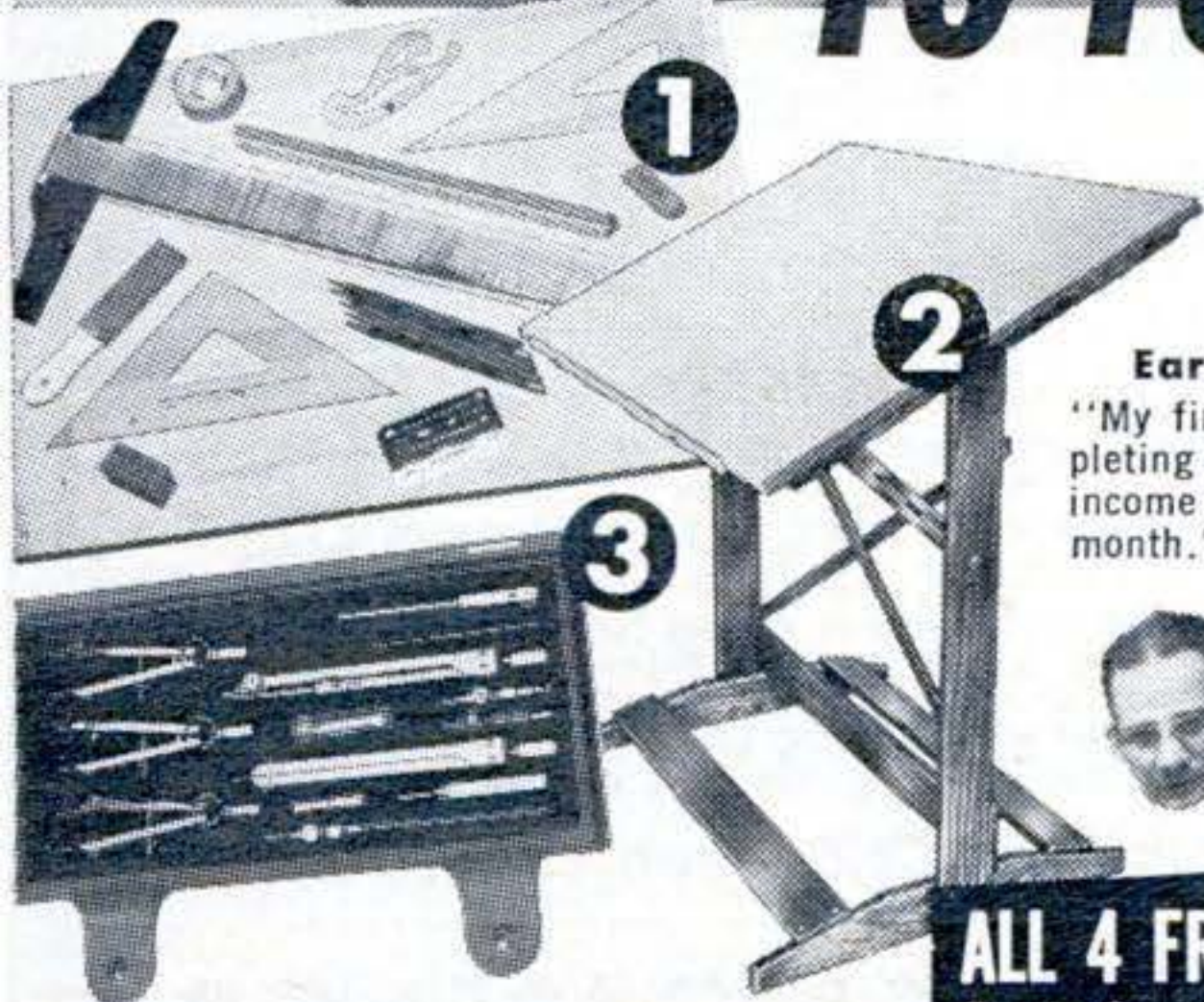
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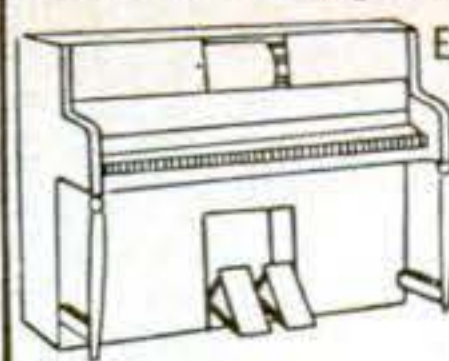
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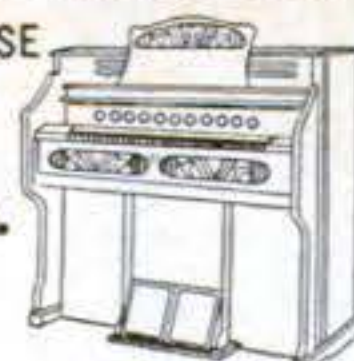
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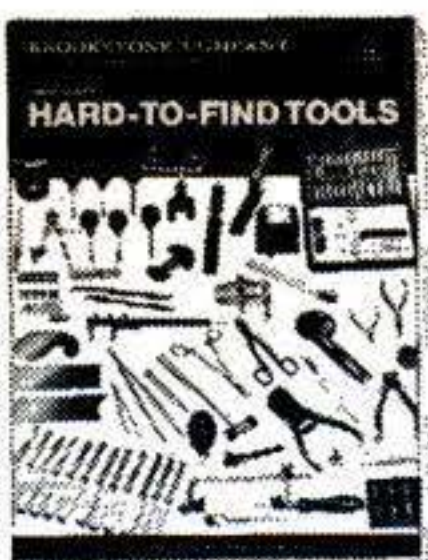
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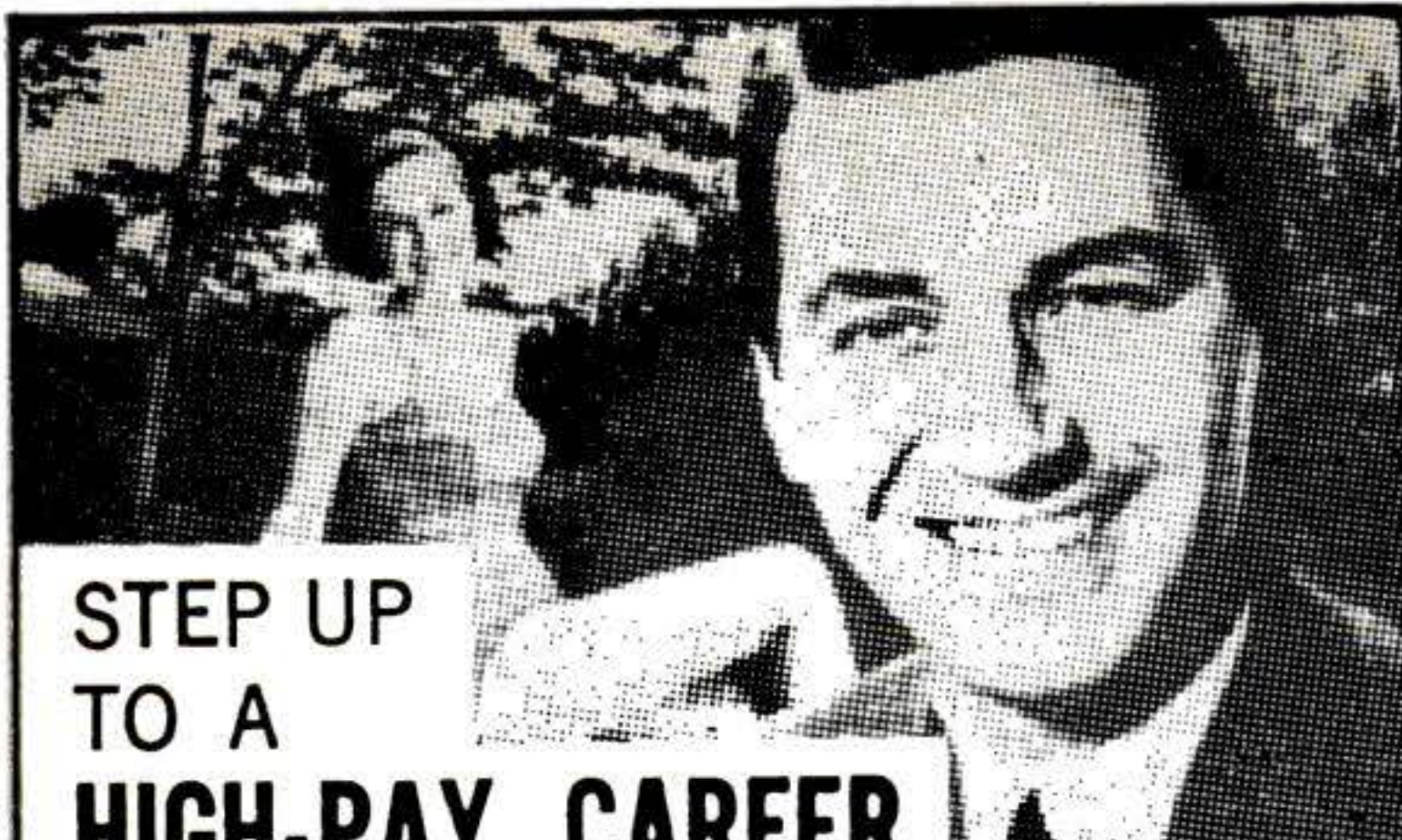
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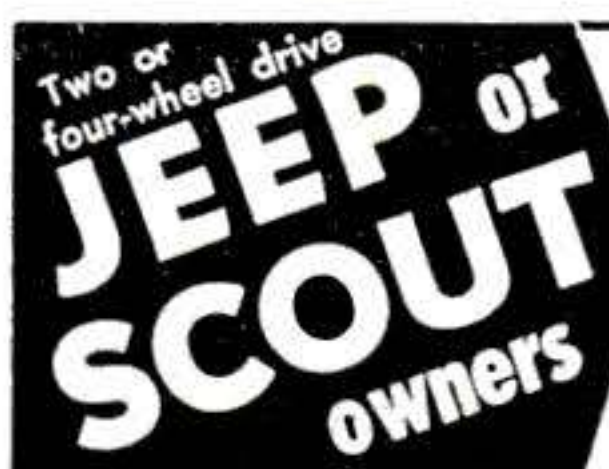
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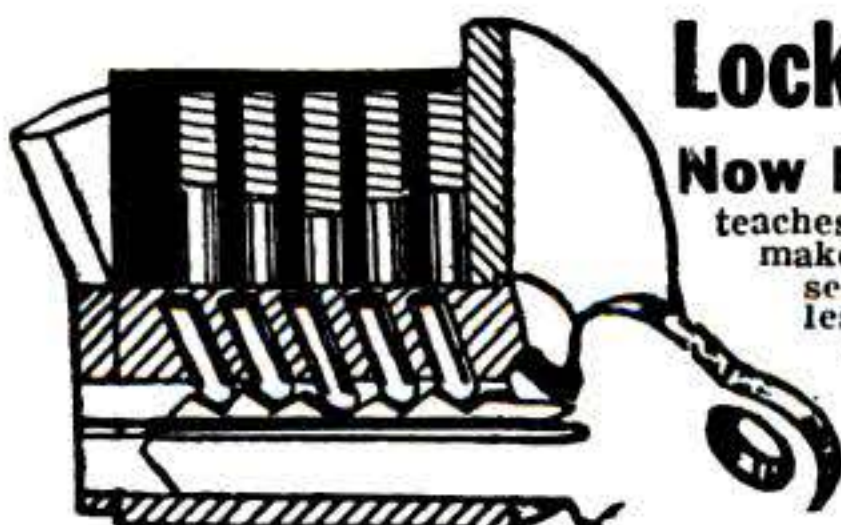
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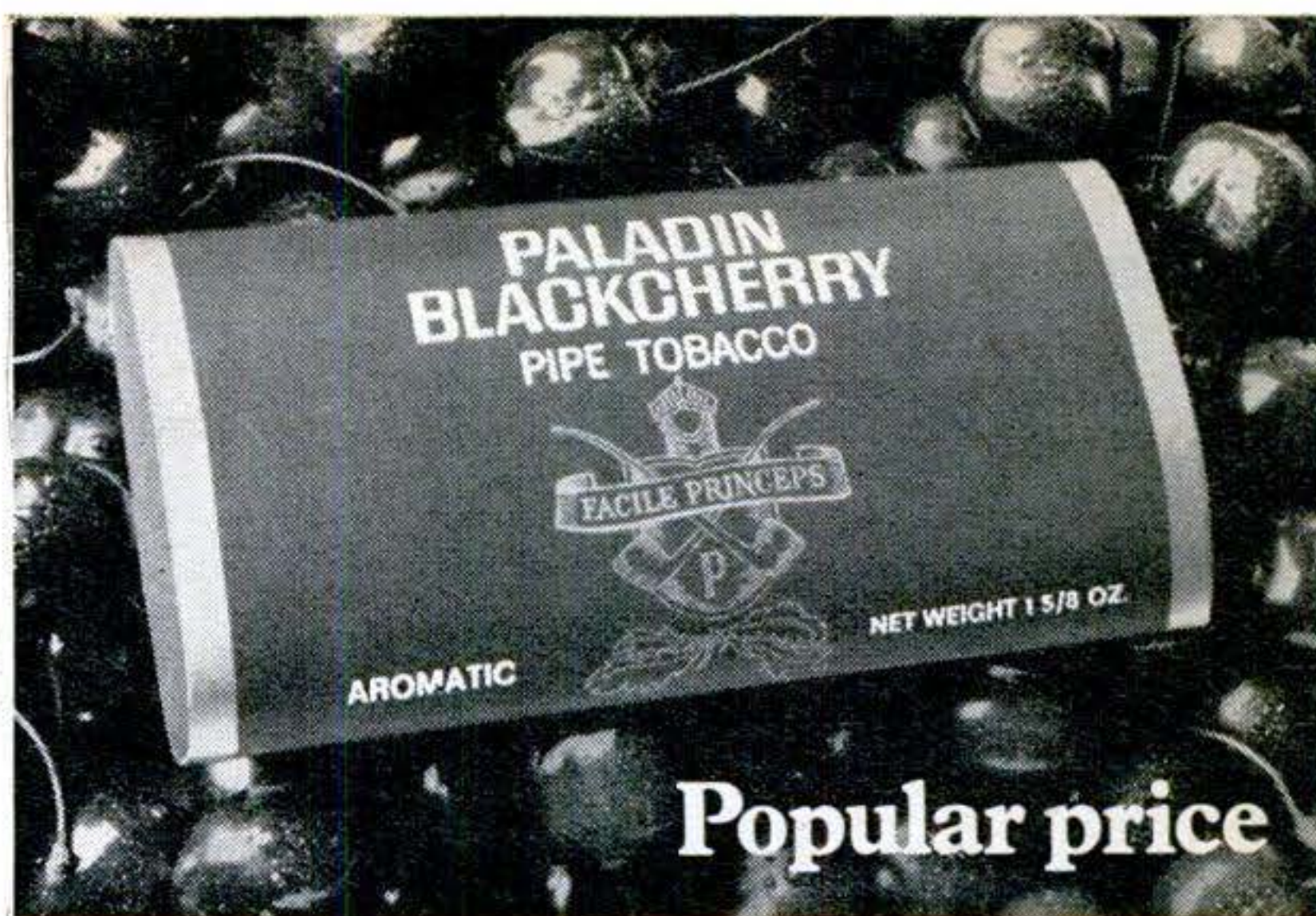
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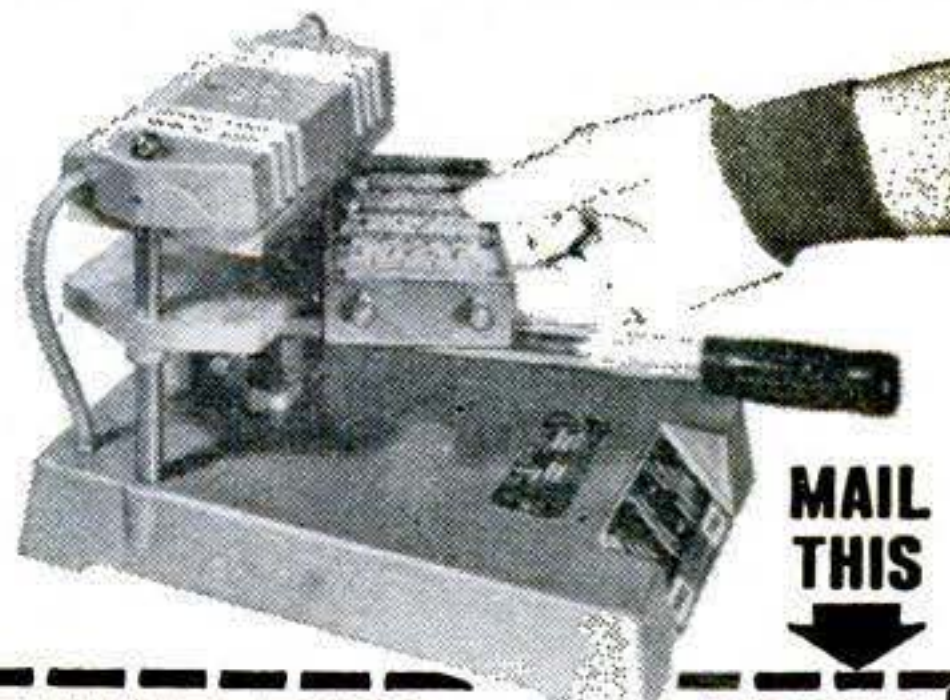
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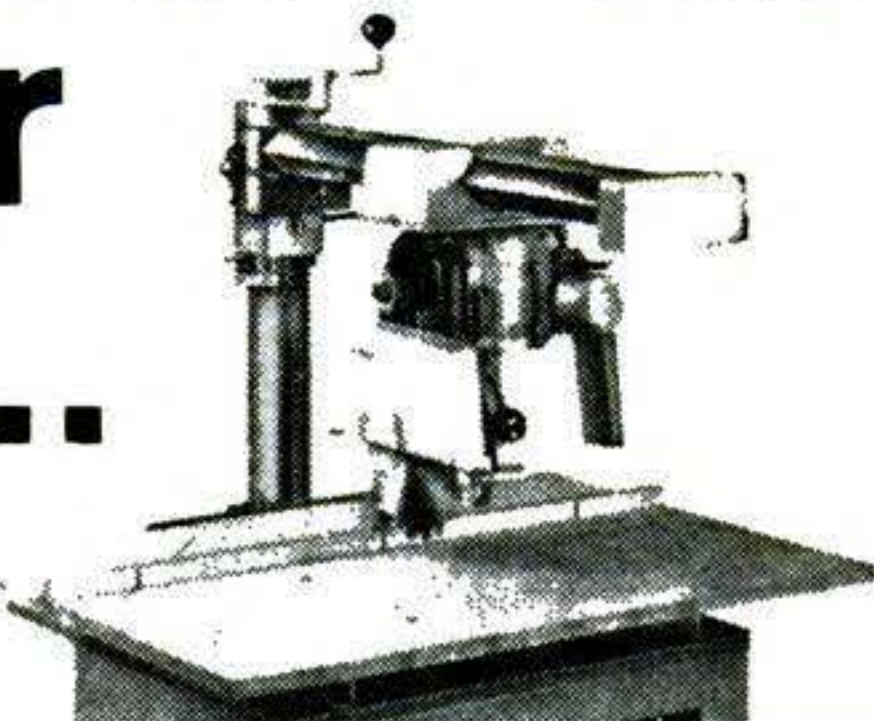
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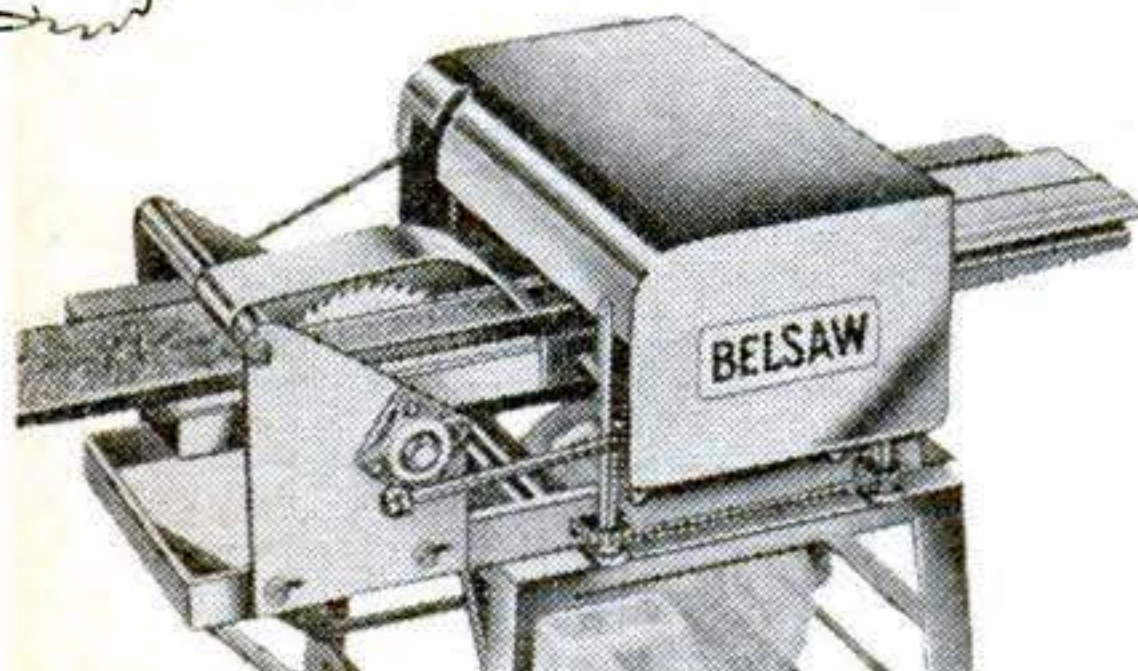
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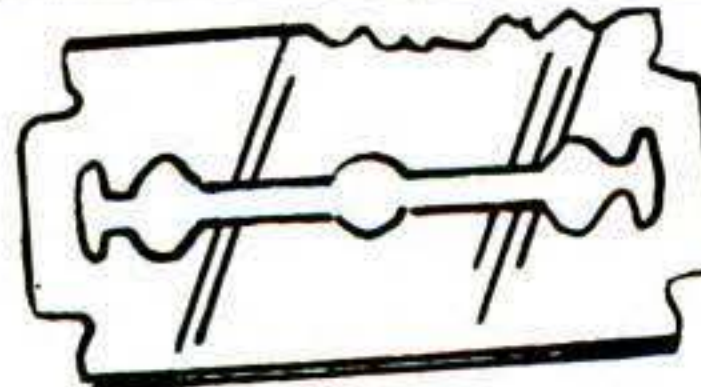
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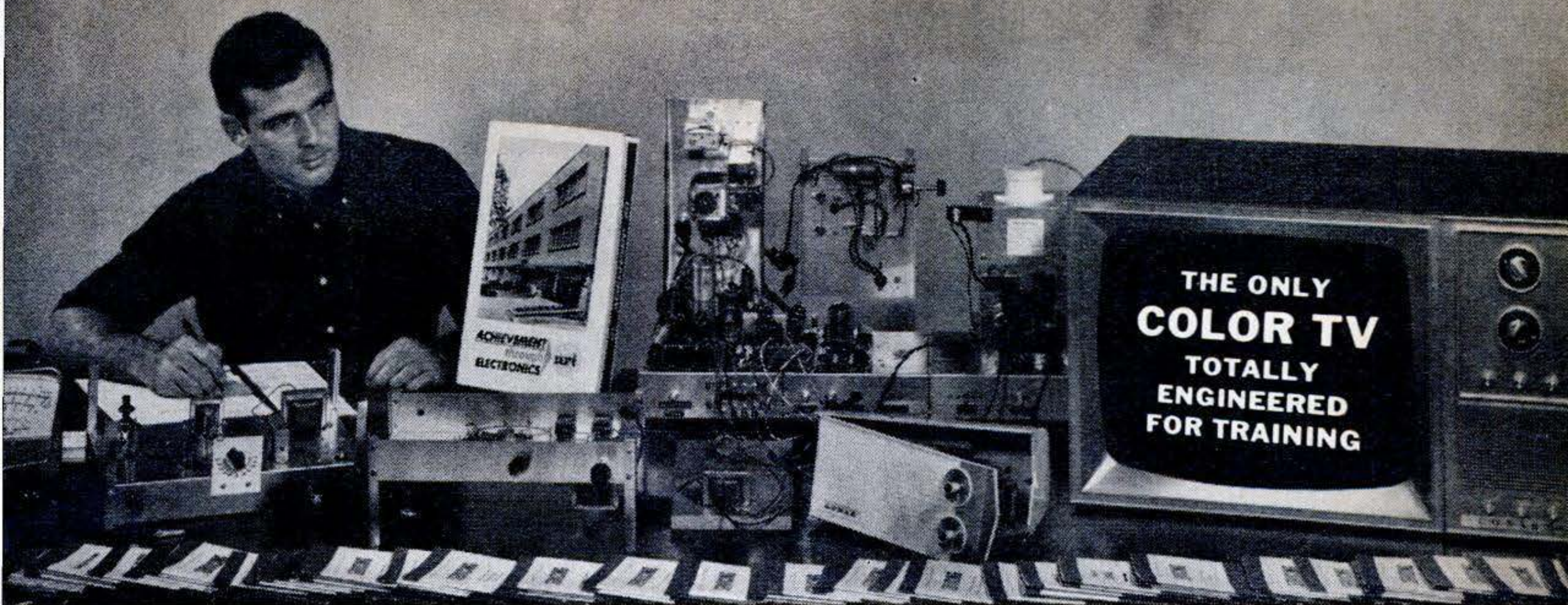
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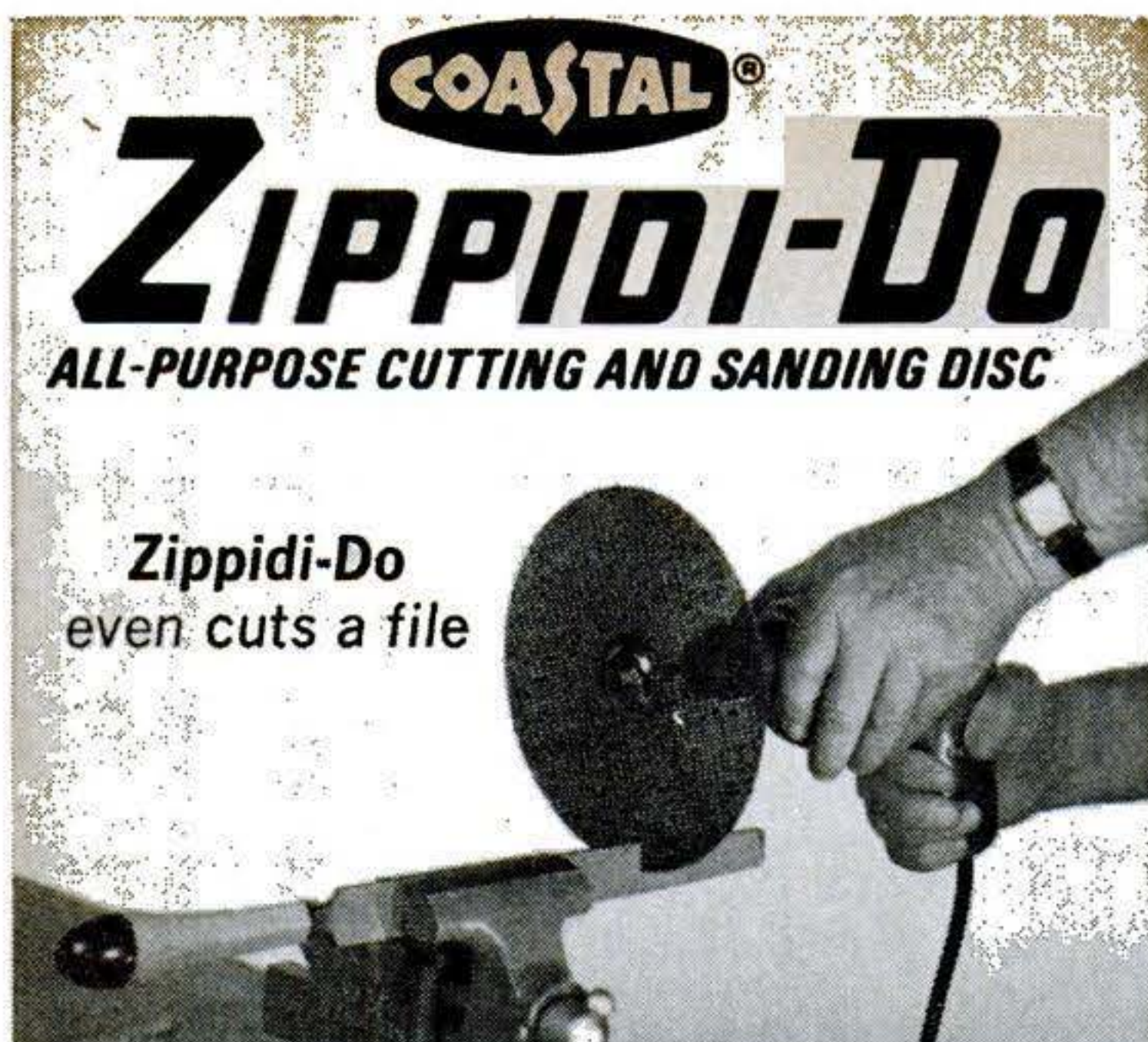


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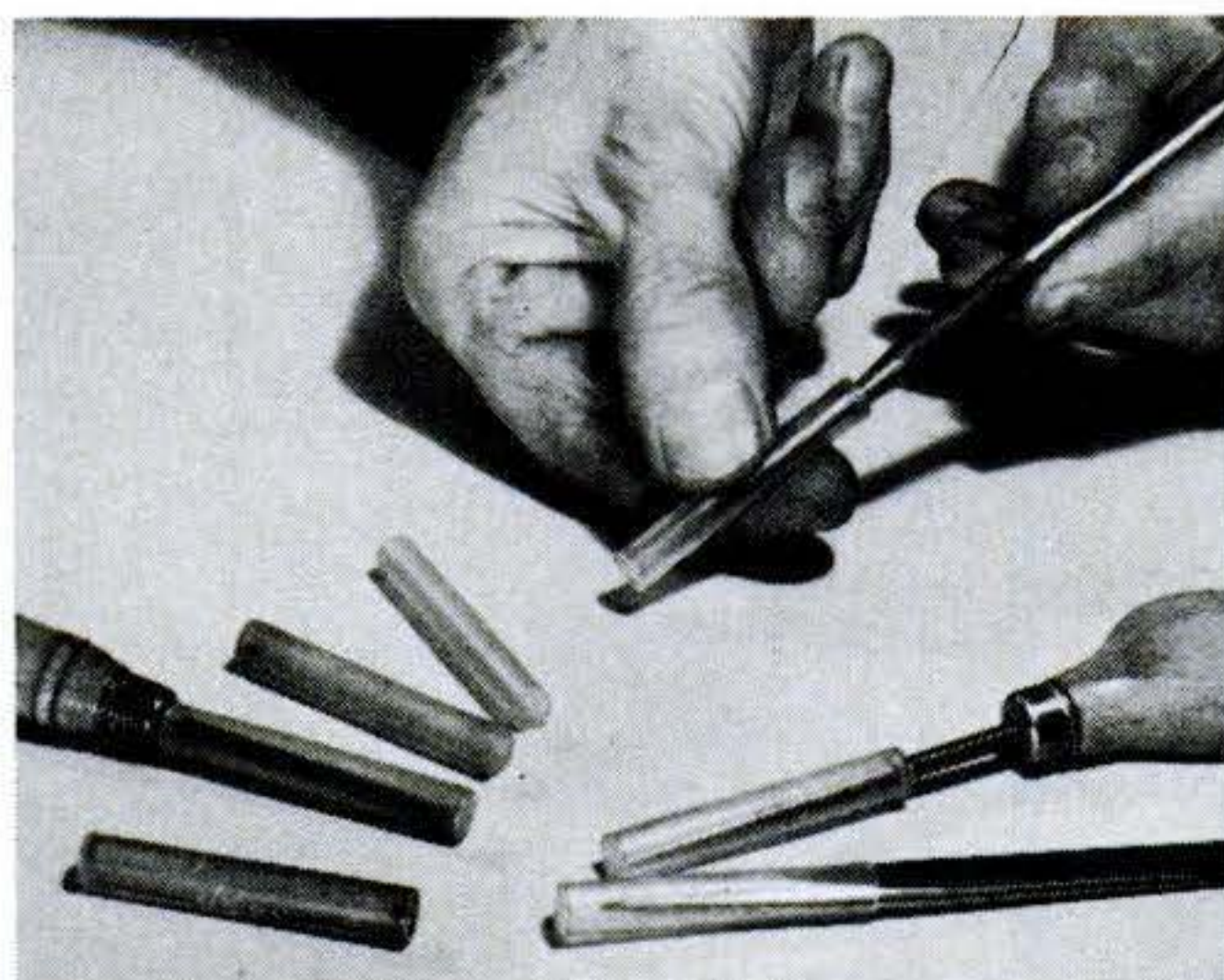
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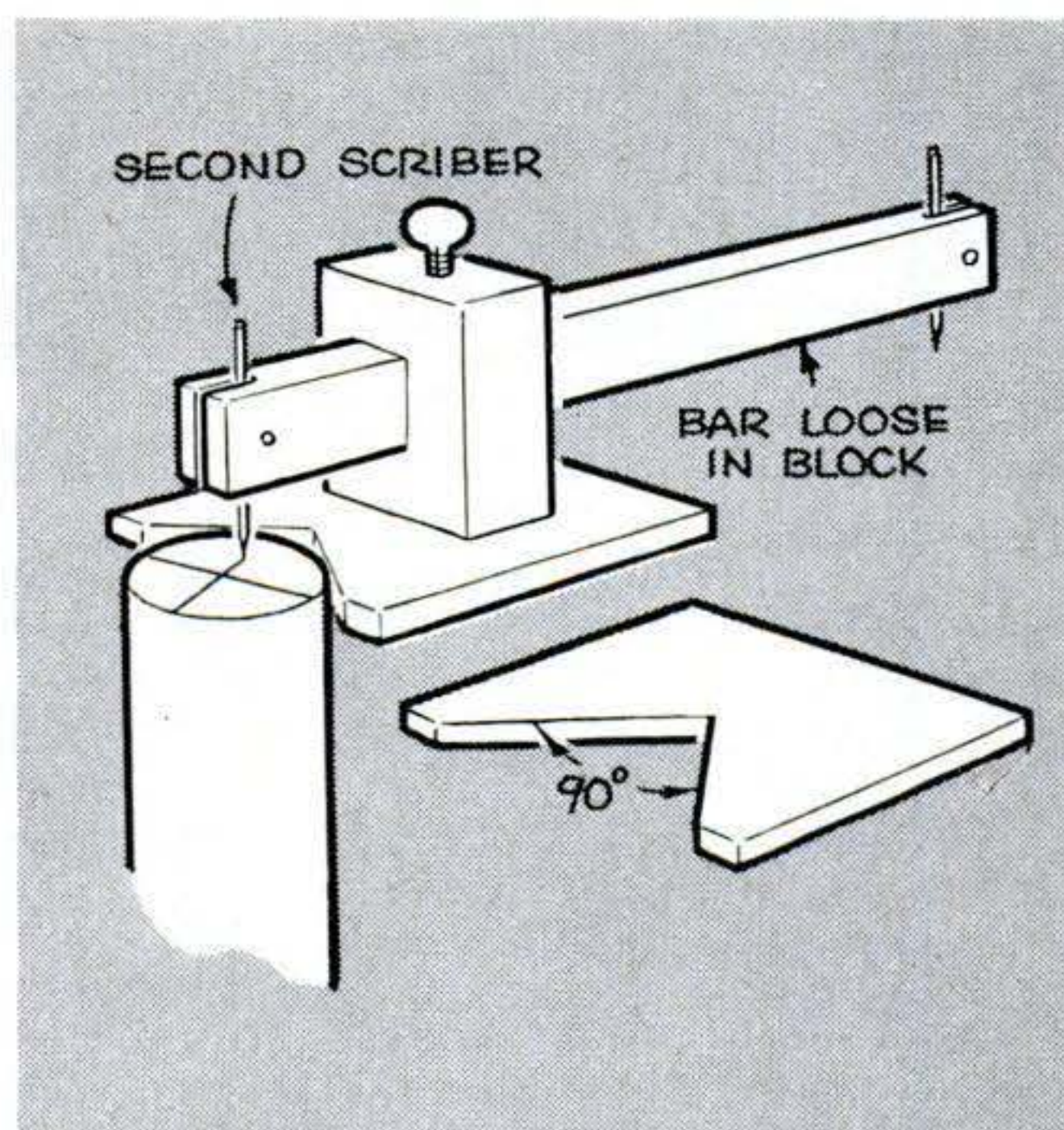
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WALTER E. BURTON, Akron, Ohio.



Use marking gauge as center finder

To pinpoint centers with your scratch gauge, first drill for a second scriber at the opposite end of the bar. Cut a 90-degree V in a piece of wood or metal and attach this to the block in line with the new scriber. With the bar loose, draw the scriber across the work.

PETER LEGON, Malden, Mass.



new champ of the lightweight division

The new Skee-Horse Lightweight comes on fast. Teaming a brawny 25 horse engine with a slim 15½" wide track, this one is quick, agile and fun. The engine has a flat torque curve so there's no gap between gas and go. The Skee-Horse snowmobile moves out—right now!

Our engineers also gave the steering a whole new geometry. Effortless. Precise. To match the cat-quick action of this sizzling snow-goer. The track has the grab-and-go traction of steel cleats, and it's built to last, just like the rugged chassis. The Skee-Horse will go. And go. And go some more.

When you stop it, you'll be impressed again. Caliper disc brakes. Though stopping is good, starting

is even better. A compression relief valve takes all the agony out of sub-zero starts. And a true neutral lets you warm up the engine without having to tip over or prop up the snowmobile.

There's also an armload of extra value that comes with the name Johnson. Like an American made engine for fast, sure service and parts. And the reliability of a two cylinder power plant.

Skee-Horse Lightweight. Hot power. Slim frame. Sure handling. Fresh styling. Johnson dependability. At a price that'll fog your goggles. Visit your dealer. Or write for a free catalog. Johnson Motors, Waukegan, Illinois 60085, Dept. PS-S911.



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Johnson
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THE SKILLFUL DRIVER 2

If Your Gas Pedal Sticks...

Traffic is bunching up in front of you, so you take your foot off the gas pedal. Instead of slowing down, the car keeps right on going at the same speed! The throttle linkage is sticking. Use the brakes, and—if you have time—try to lift the gas pedal with your foot. That might free the linkage. On some cars, however, lifting the gas pedal merely disconnects it from the

throttle linkage, so it may do no good.

Keep the car in Drive or the gear engaged to be sure the engine is working under load. Protect your engine against over-revving by switching off before you move to Neutral. When you reach the shoulder, turn off the ignition, and stop. Get under the hood and free the sticking linkage. Lubricate it if necessary.

.....

Have you ever been in an emergency situation on the road, and got out of it in masterly fashion? Have you had a narrow escape from a dreadful collision? Other drivers would like to know your

experience—and your expert advice. PS will pay \$25 for your contribution, if selected for publication. Send it to Skillful Driver, POPULAR SCIENCE, 355 Lexington Avenue, New York, N.Y. 10017.



Dodge



For the Smart Swinger... the Dart Swinger.

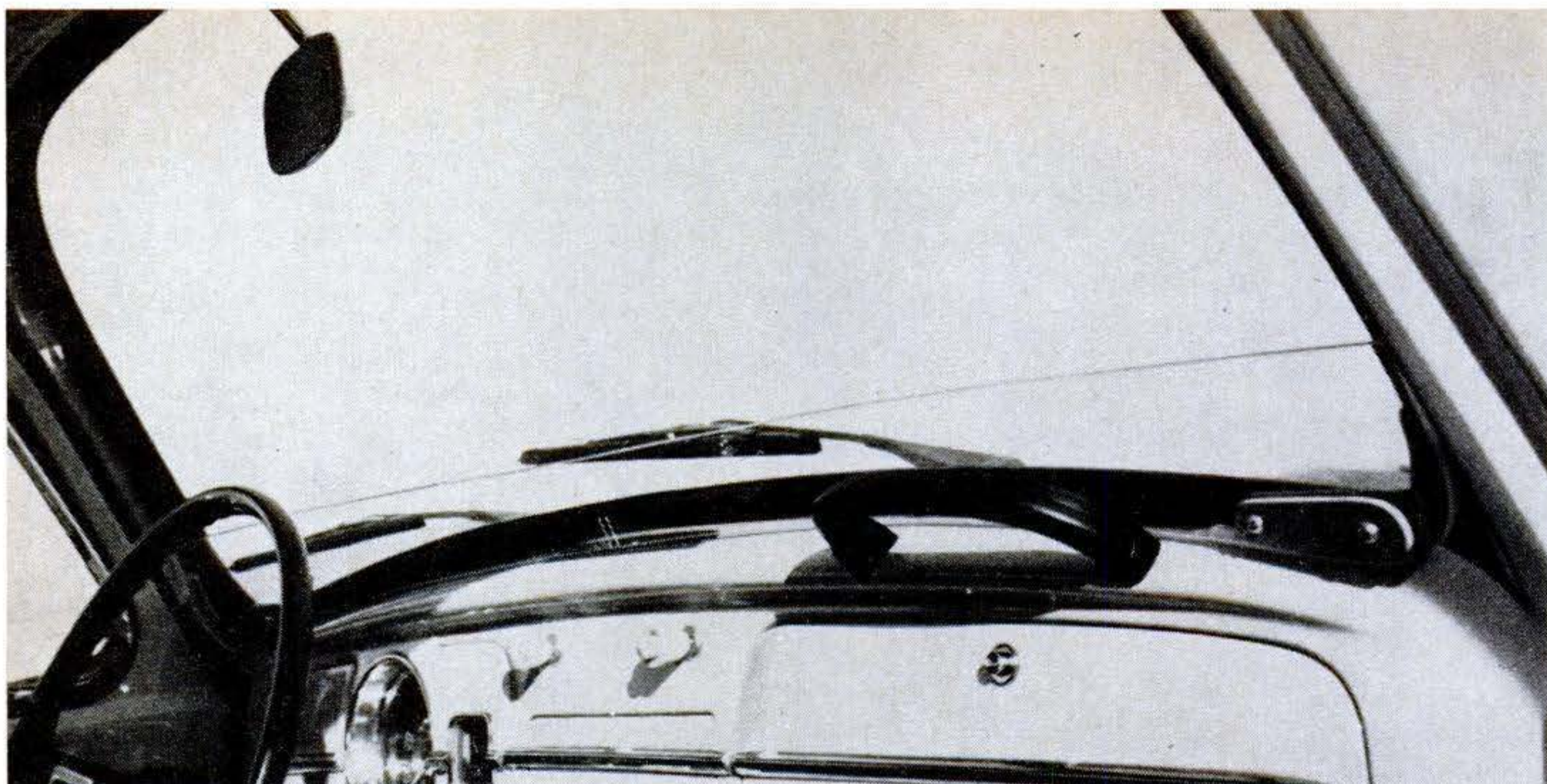
If you're a swinger who thinks your budget can't swing a new car this year . . . take a look at the new Dart Swinger. Our lowest priced two-door hardtop. Swinger's big and roomy inside for that big-car ride. With all-vinyl seats that carry six of the gang around in style. And new, larger standard engines. A mini-fuel 198-cu.-in. Six and a maxi-power 318-cu.-in. V8. Dart Swinger. One low-priced compact that doesn't slight you on looks, comfort, or extras. See Dart Swinger soon.



If you won't
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for an answer . . .

you could be
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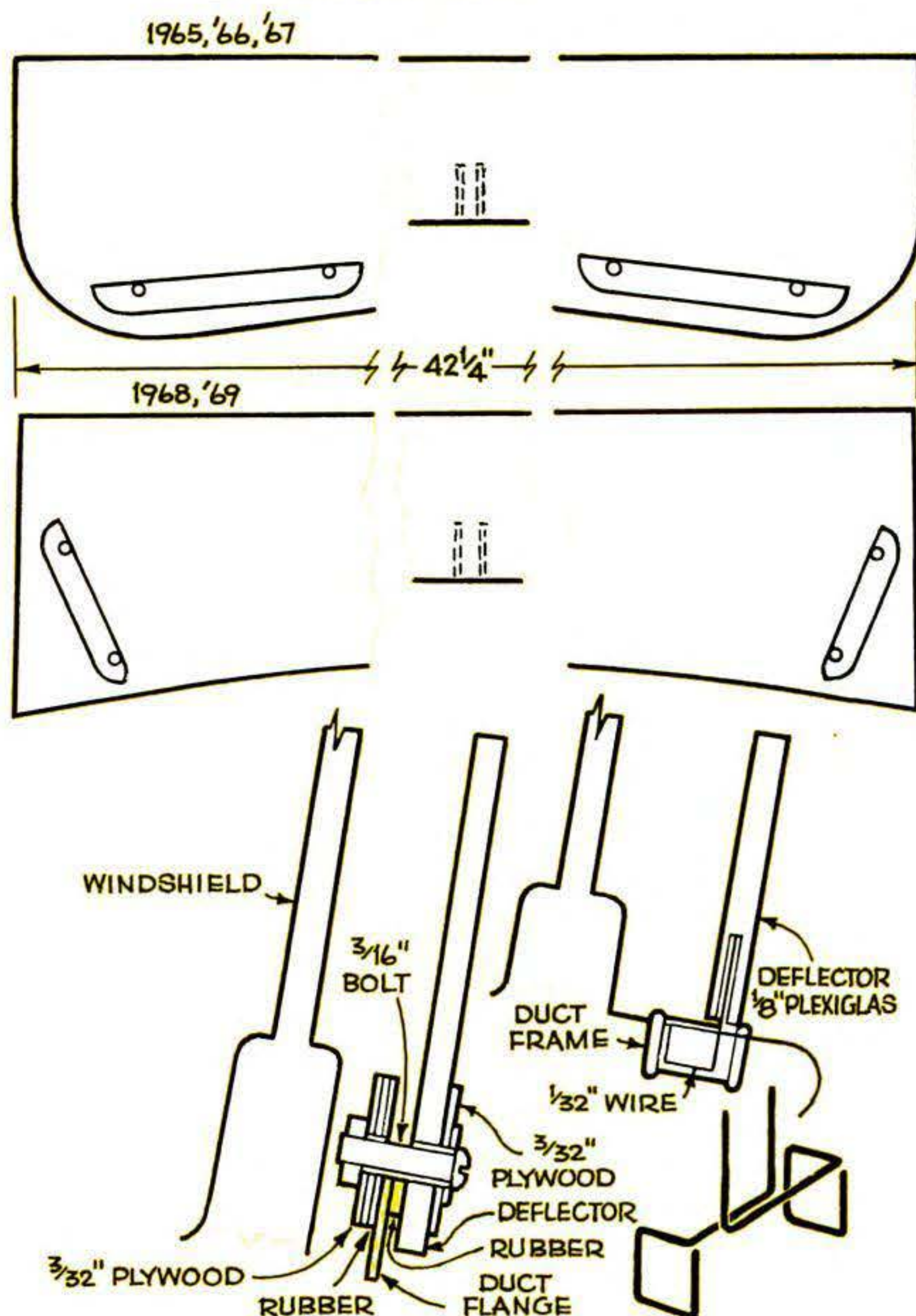




Plexiglas deflector shoots more warm air upward onto the windshield to melt snow and ice.

Deflector Puts Heat on VW Windshield

By JOHN RITNER



My deflector clamps on the car's defroster vents without marring the finish. One of the shapes shown will fit any bug from 1965 to 1969. For earlier models make a 1965-67 pattern of cardboard and trim to fit.

Bandsaw the appropriate shape from a sheet of Plexiglas with backing paper left on; smooth the cut edges by flame polishing with a propane torch. Laminate enough wood and rubber with contact cement to bandsaw the two clamps from a single piece. Using a clamp as a pattern, cut the rubber pad that's contact-cemented to the Plexiglas. Oil-finish the wood parts or seal and paint them to match the car.

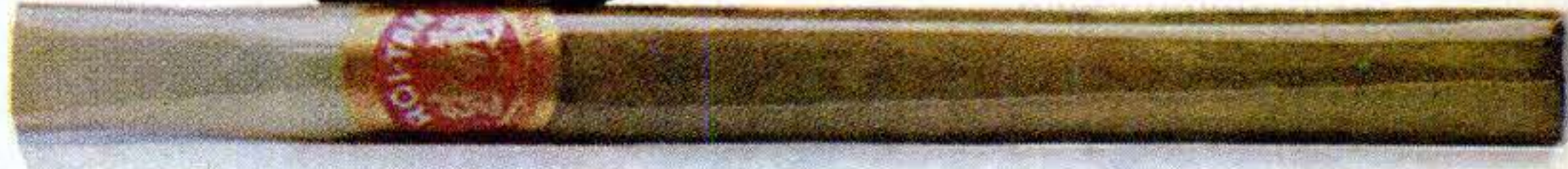
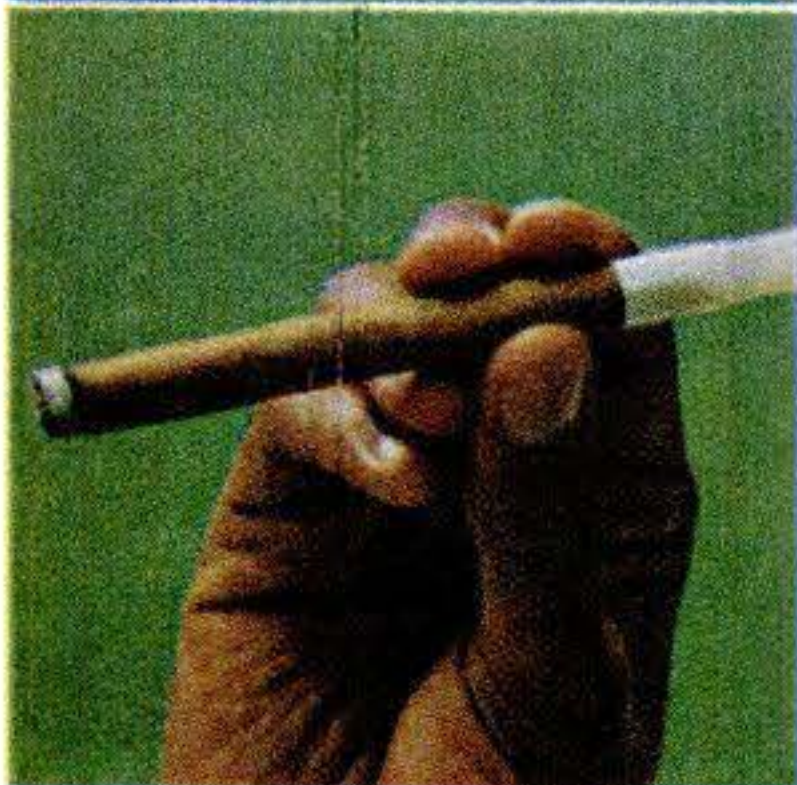
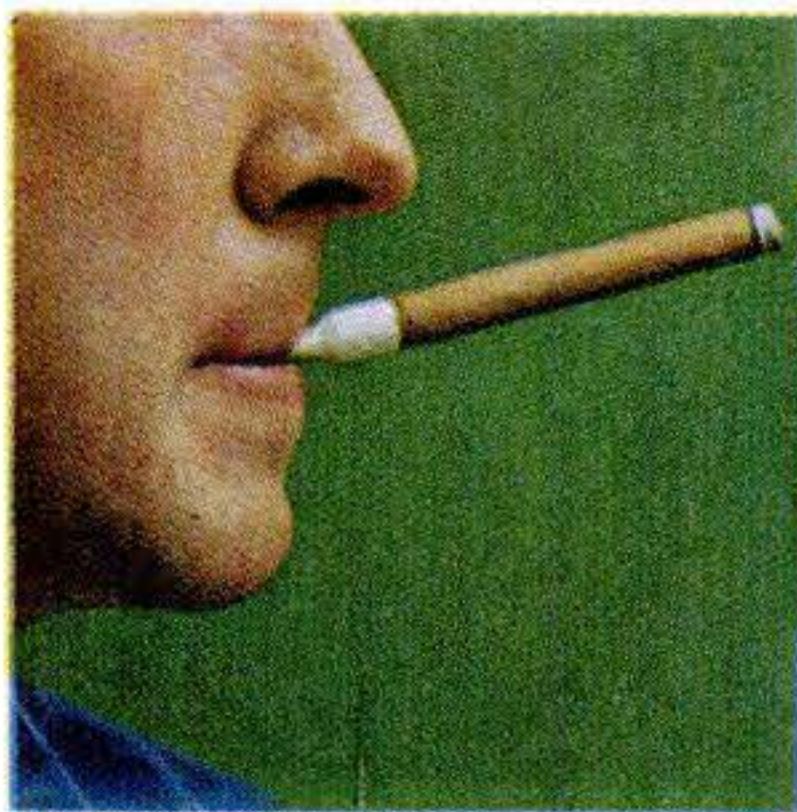
Pins prevent the deflector from bowing in the middle as heat expands it. The pins fit into holes in the deflector's bottom edge; they're braced against grids in the center defroster vent.

A 5¢ Bargain right under your nose.

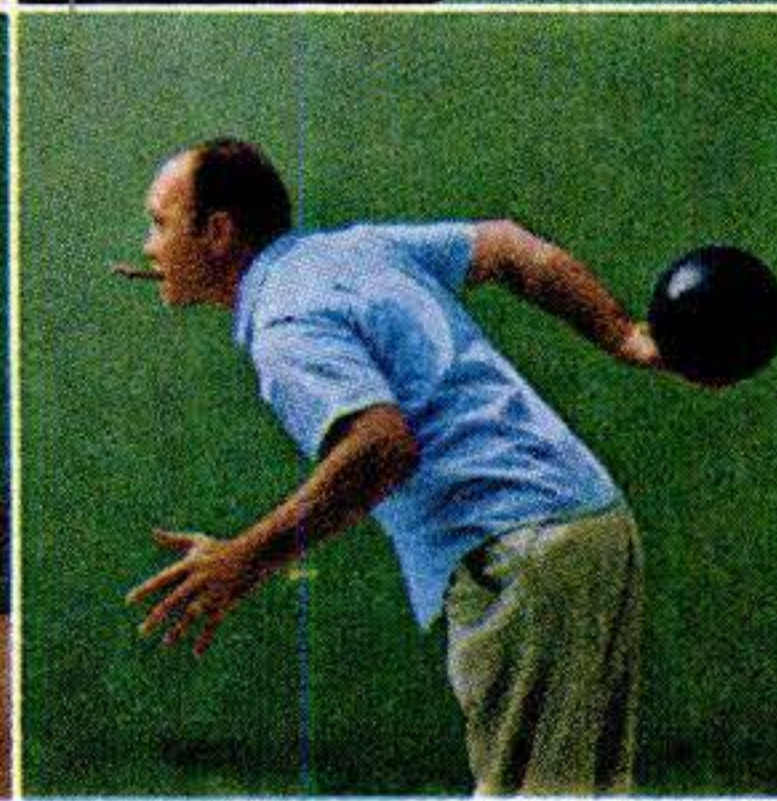
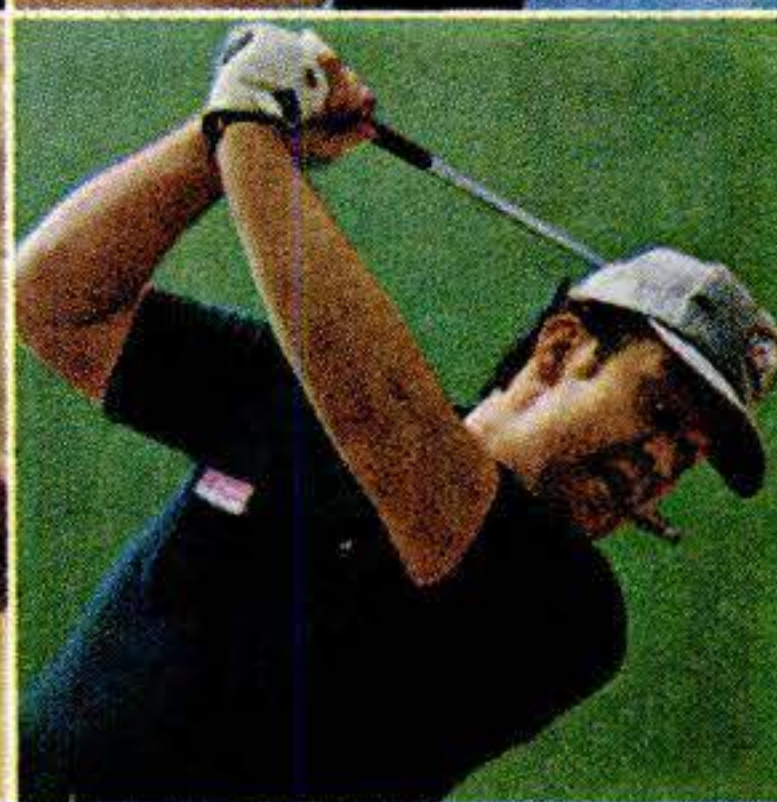
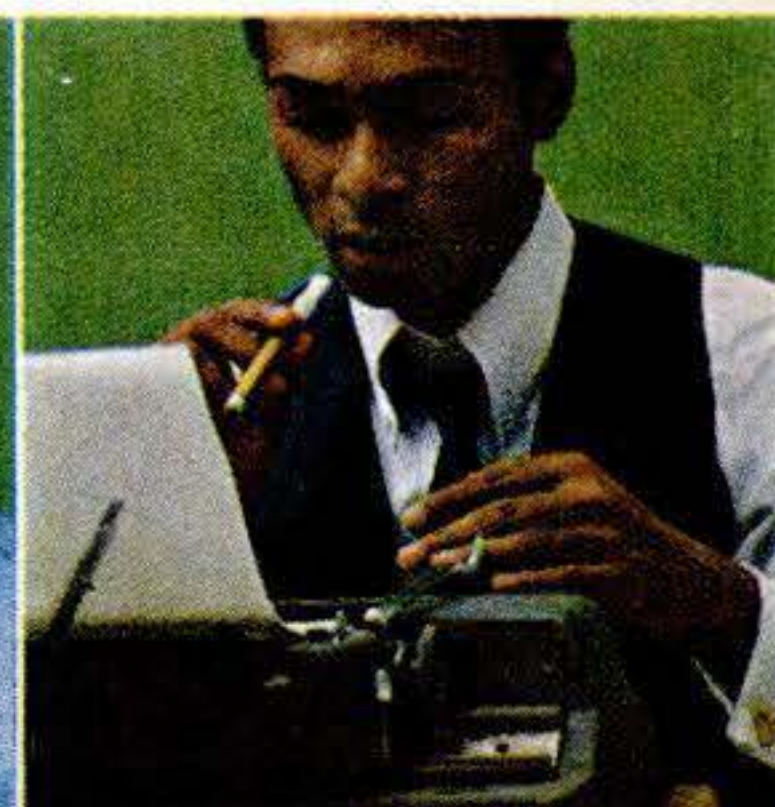
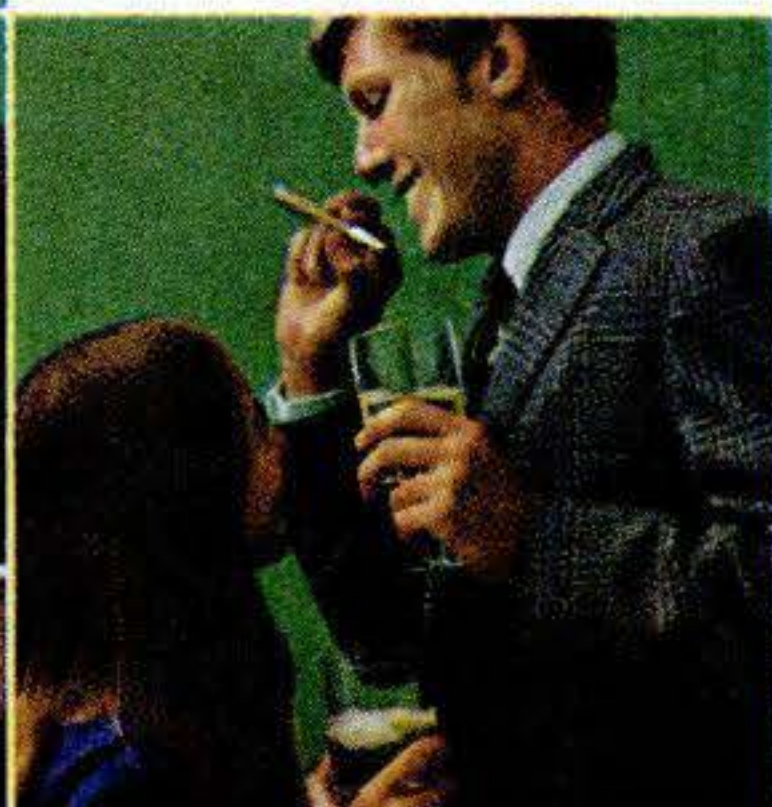
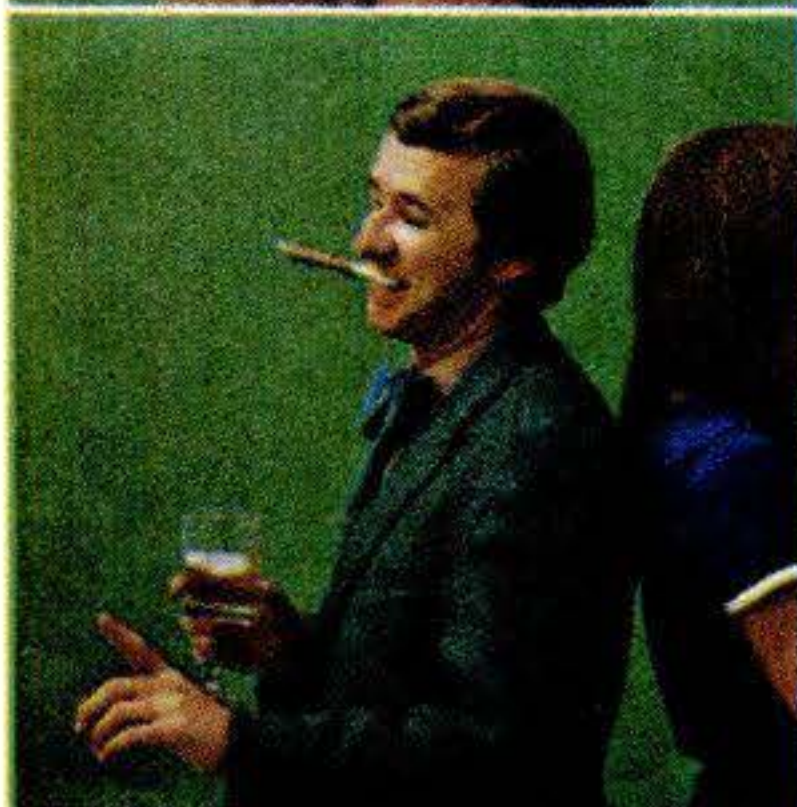
Our full-sized Roi-Tan has such great taste it's the best selling 10¢ cigar. So now we'd like to tell you about a 5¢ bargain that tastes every bit as good.

It's the Roi-Tan Tip. It costs the same as a lot of other tipped cigars, but that's where the similarity ends.

And, we make two other 5¢ cigars, besides. Trumps and Cigarillos and a 4¢ cigar called Golfers. They all have that great Roi-Tan taste. And they all cost a nickel or less.



Roi-Tan The Crowd Pleaser.



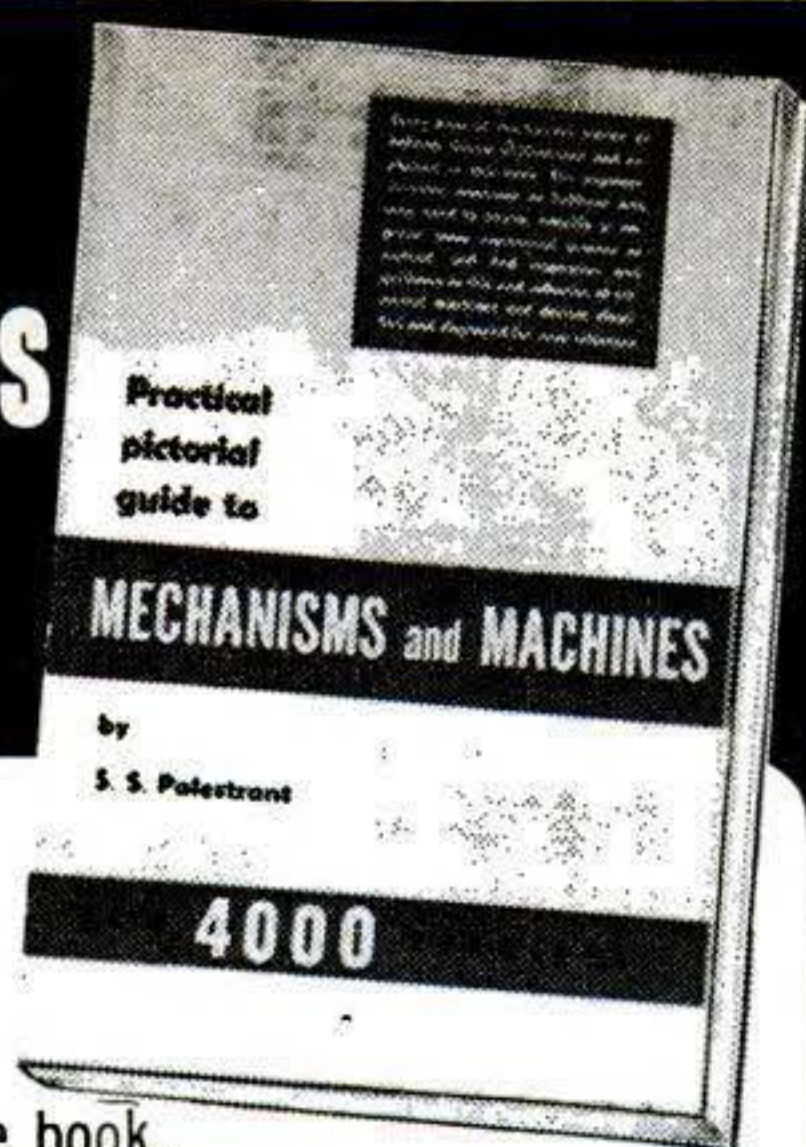
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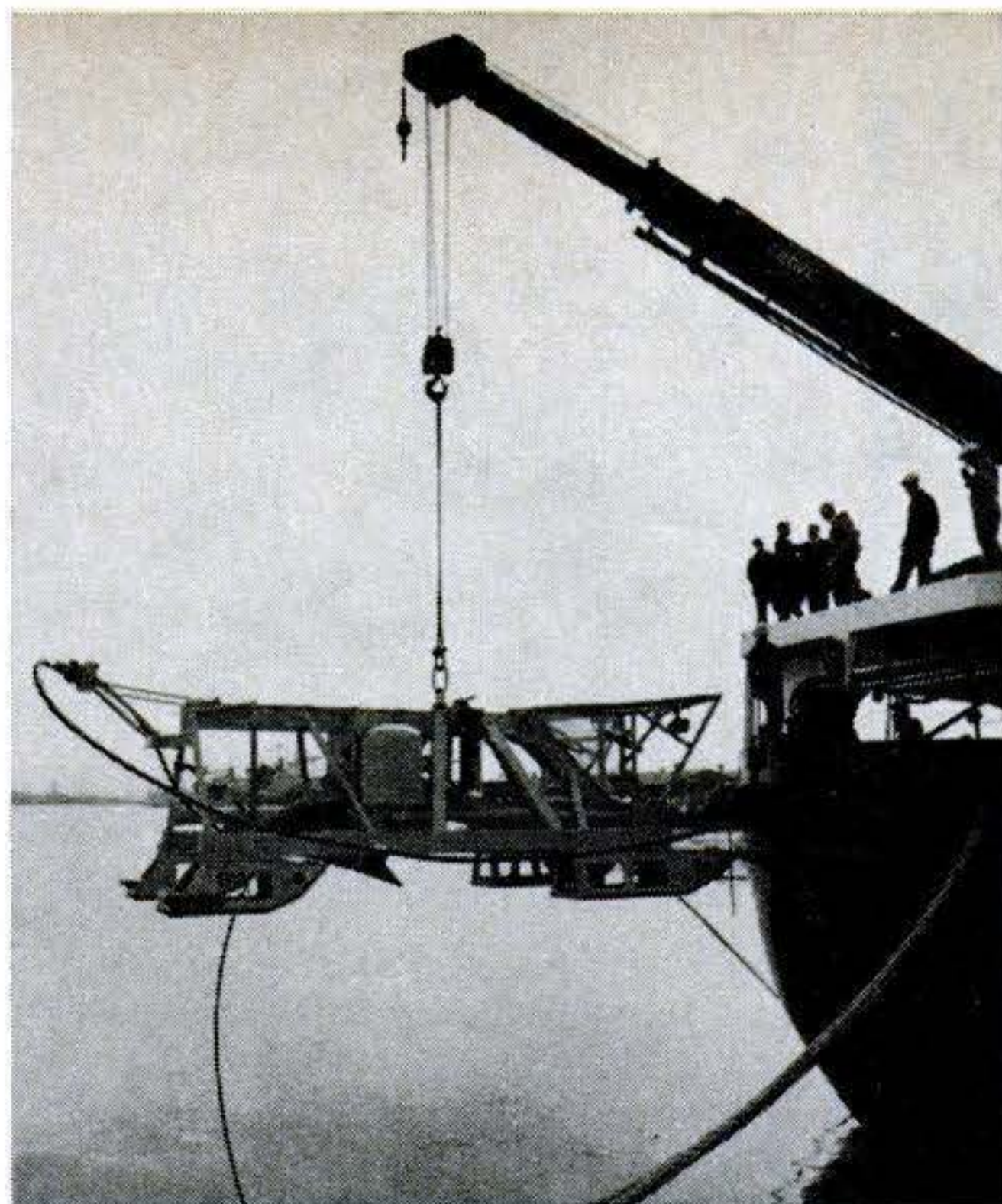
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PS-11-69



Plow is lowered over the stern, then towed on ocean bottom, burying telephone cable as it goes.

Sea plow buries phone cable

Transatlantic telephone cables lying on the ocean floor—armored though they are—are vulnerable to damage from trawlers. To beat this, Bell Telephone has developed a sea plow that will lay lighter, unarmored and less costly cable two feet under the bottom. TV cameras and instruments attached to the plow report details of operation to the tow-ship's bridge via an all-purpose control line.



Cable enters plow orifice under eyes of TV lights.

Canada discovered
the snowmobile

Evinrude civilized it



Result: the Evinrude Skeeter

The snowmobile was a one-way machine — till Evinrude came along.

We gave it Reverse — to get it out of corners and keep you out of trouble. And a new torque-sensing drive that automatically matches the power to the need. And electric starting.

We widened the track — to give it trail-

blazing flotation and sure-footed stability in soft snow.

For power, we developed a smooth, twin-cylinder engine. An Evinrude engine, with Evinrude-built parts that can be serviced by any Evinrude dealer.

While others were catching up — we went on from there. We made the

steering easier. The quiet quieter. The ride more comfortable. The range greater. The performance livelier. And everything more reliable.

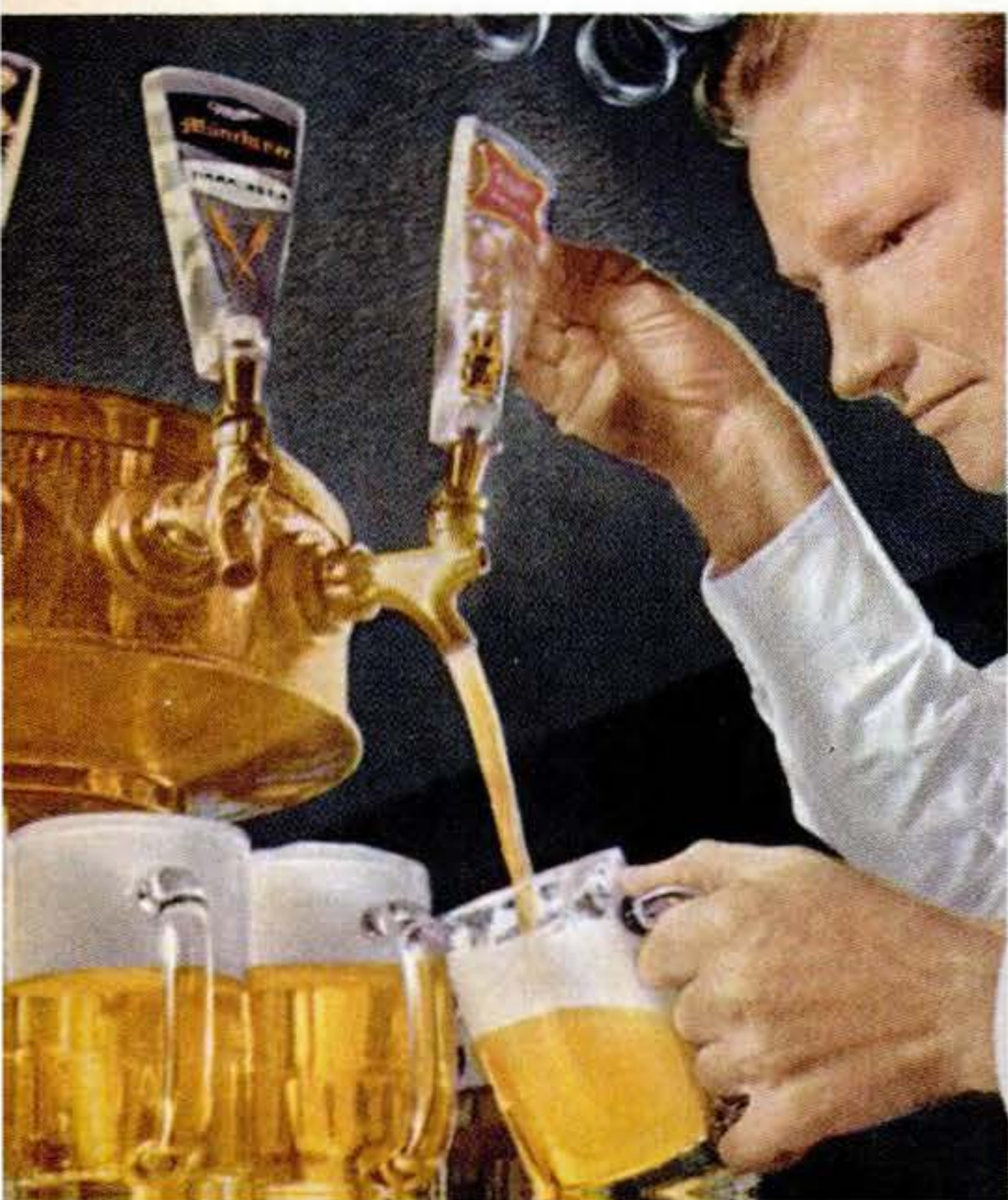
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An exclusive report, by the only man to try the famed Rocket Belt's sensational successor, tells how it turns you into a jet-engined flying machine — and what you can do with it

What It's Like to Fly the New JET BELT

By Test Pilot Robert Courter

*Chief of Small Lift Devices Flight Test and Operations
Bell Aerosystems Company Division of Textron Inc.*

When Buck Rogers zoomed across the comic pages with his trusty flying belt, a few decades ago, his "25th century" style of locomotion looked as unlikely as the prospect of flying to the moon. But fact has overtaken science fiction. Now—like going to the moon—a practical flying belt is for real.

On April 7, 1969, I piloted Bell's new Jet Flying Belt on its first manned free flight at Niagara Falls, N.Y.—by coincidence, the "capital city of Earth" in Buck Rogers' adventures.

Put on the Jet Belt, powered by the world's smallest fanjet engine—and you become a flying machine, without need of wings. Says Textron's Bell Aerosystems Company, which developed the Jet Belt under a U.S. Army contract sponsored by

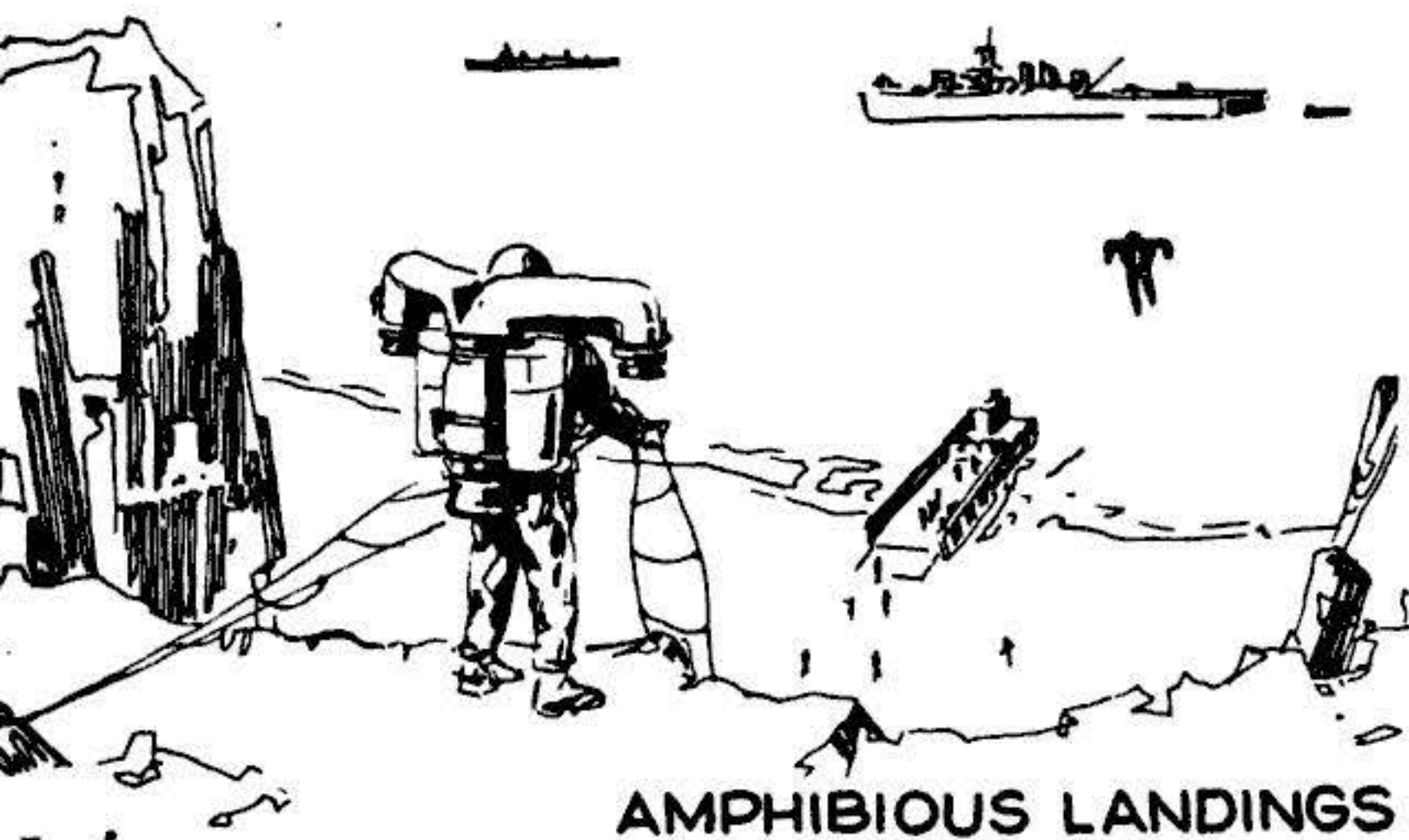
the Advanced Research Projects Agency:

"The new mobility system will enable men to fly over rivers, cliffs, and canyons, or such man-made obstacles as mine fields, barbed wire, buildings, and highway traffic. The scope of military and civilian applications is limited only by the imagination and ingenuity of potential users.

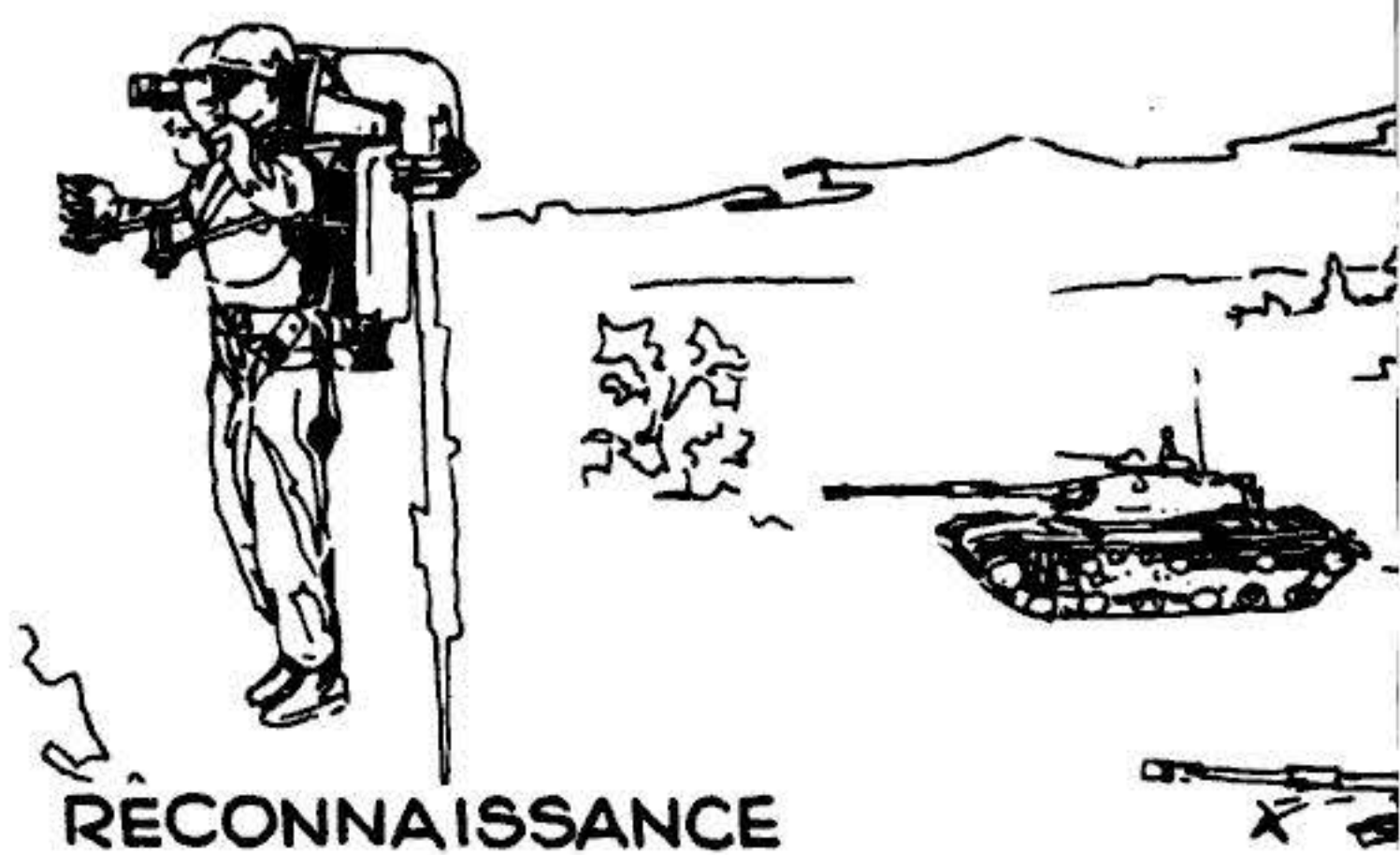
"Reconnaissance, artillery spotting, counterinsurgency warfare, ship-to-shore operations, and perimeter defense are military operations considered within the Jet Belt's capability. Civil applications include traffic and riot control, fire-fighting, rescue operations, rooftop and high-building patrols. . ."

Conceivably the Jet Belt could even become the commuter's vehicle of tomorrow.

Continued



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RESCUES

Jet Belt will have military and civilian uses

Here are examples of Jet Belt's applications. It could fly fighters to strategic spots to aid an amphibious landing, and ahead of advancing force to scout out enemy. Civilian user could speed to forest-

fire scene for report to guide firefighters, or carry rescue line to men on stranded ship. Cliffs, canyons, and bodies of water offer no obstacles to a man in a hurry who has this personal flying device.

Maybe someday your "second car" will be a flying belt garaged in the hall closet.

The new Jet Belt is a successor, with vastly improved capabilities, of Bell's famous Rocket Belt.

It was the Rocket Belt that first realized man's age-old dream of flying without an aircraft, almost as free as a bird [PS, Dec. '61]. Since 1962, when I joined the Bell company as a test pilot, I have logged well over 1,000 Rocket Belt flights myself.

With the Rocket Belt you can soar as high as 100 feet and at more than 60 m.p.h. But its hydrogen peroxide propellant lasts for only 21 seconds of free flight, and its range of about 300 yards is obviously too limited for a practical individual-mobility system. A flying belt plainly needs a less fuel-hungry power plant.

The answer is the Jet Belt's midget jet engine. It burns standard kerosene-type

jet fuel. Consumption is low. Compared with the Rocket Belt, the endurance of the new Jet Belt is measured in minutes instead of seconds—and its range, in miles instead of yards.

Flying the Jet Belt. What is it like to fly with the jet version? First, you can be your own ground crew—unlike the Rocket-Belt pilot, who needed a couple of skilled technicians to service his vehicle and to handle its ticklishly unstable fuel safely.

I back into a fiberglass "corset" and strap myself into the harness of the Jet Belt. While I'm doing this, a retractable stand supports it on the ground. (At first, before it was provided with a built-in stand, a separate one on the ground served the purpose; that is why you do not see a stand on the Jet Belt in the flight photo on the opposite page.)

To start the miniature engine, I trigger a solid-propellant cartridge that

spins it and ignites the fuel.

With the throttle, a twist grip in my right hand, set at "ground idle" position, I check controls and instruments. I advance the throttle to "flight idle," and lift just offsets the weight of the belt, making it easy to move about on the ground. Before lift-off I recheck the instruments, and retract the stand.

Then I ease the throttle up. I feel myself getting light on my feet. The r.p.m. increase. I lift off, rising like an elevator.

Four or five feet up, I'm above range of ground effects—bounce from exhaust gas ricocheting from the ground—and can stabilize my flight.

How you steer. To govern attitude, and provide motive force to move in any horizontal direction, the engine's gimbaled exhaust nozzles may be deflected from pointing vertically downward, by several controls—a left-hand twist grip (for yaw control) and a pair of handlebar-like control arms (for pitch and roll control). The right-hand grip, the throttle, varies thrust to ascend or descend.

By using these controls I can fly in any desired direction—forward or backward, left or right, up or down. I can make a coordinated turn, spin on my own vertical axis, or hover at a virtual standstill.

Moving around in the "wild blue" with no airplane under you gives you a

Continued

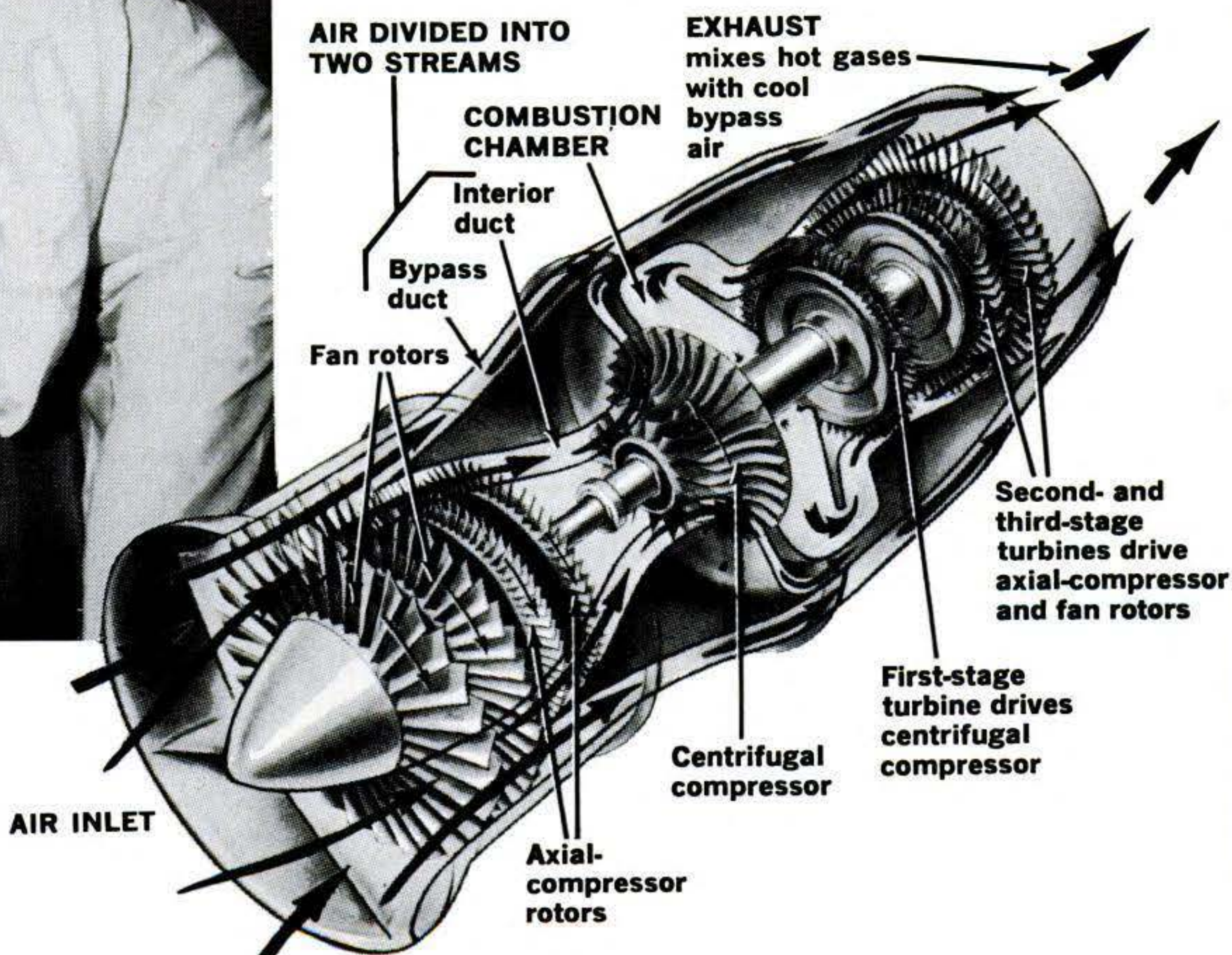
Author takes to air with new Jet Belt—which will fly him for minutes and miles. Here he's in full flight, using twist grips and a pair of handlebar-like control arms to steer himself in direction he wants to go.





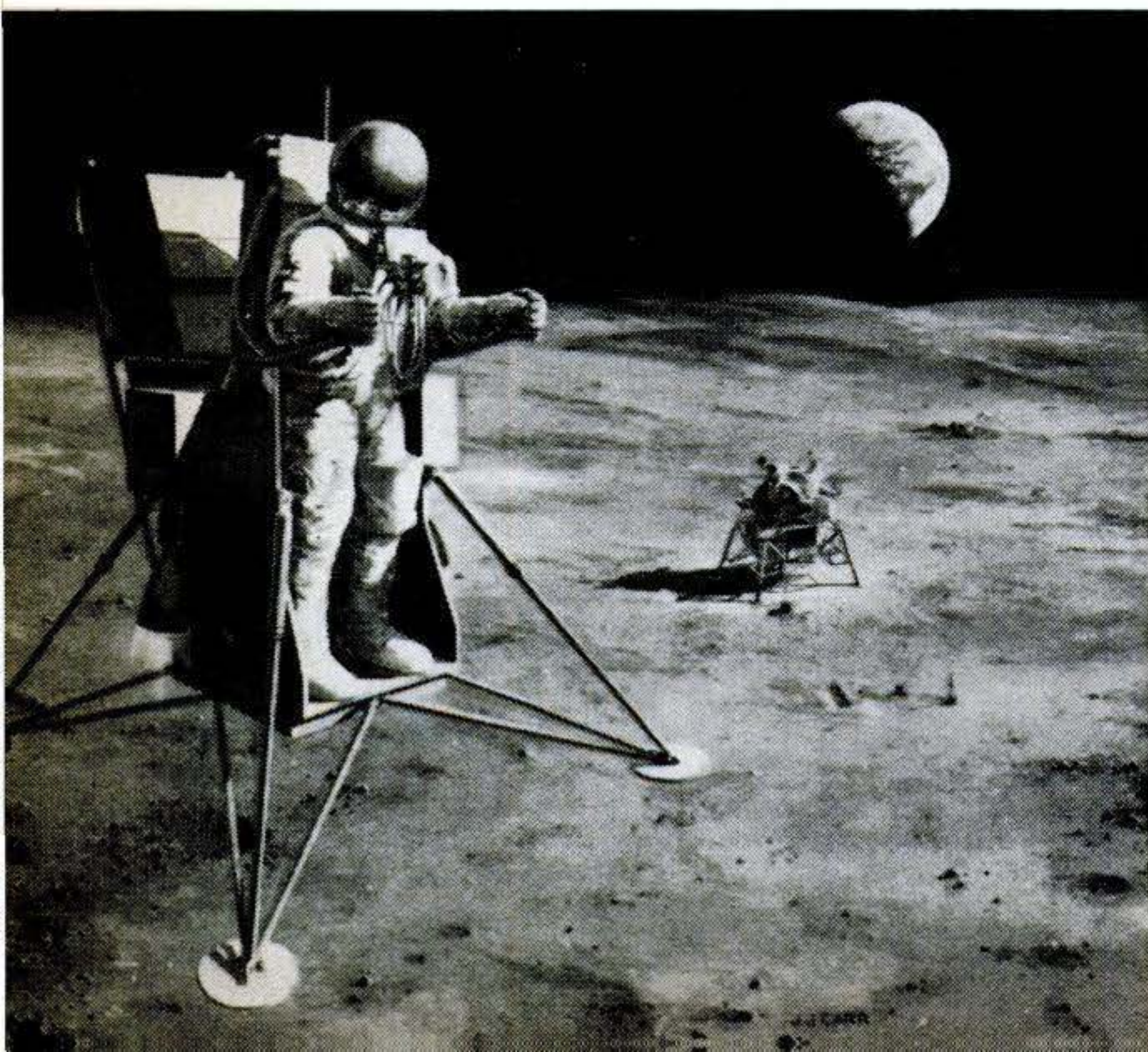
Jet Belt harnesses midget engine

Fanjet engine of new belt, being fitted with exhaust duct in photo at left, measures only a foot in diameter and two feet long. Cutaway view of it below shows how divided air stream gives cool shell and exhaust. Components' counter-rotation avoids gyro effect that would hinder maneuvering.



strange sensation. Lift-off with a flying belt is "like having a giant pick you up by the arms," as Peter Kedzierski, one of the first men to free-fly the Rocket Belt, once put it. Once you're up there, soaring as if exempt from gravity, there's a sense

Lunar Flying Vehicle being designed by Bell for NASA is latest rocket-powered offspring of Rocket Belt. Using left-over Lunar Module fuel, it is to carry a moon-exploring astronaut as far as 15 miles.



of freedom that reminds me of skin diving.

With the Rocket Belt's brief flights, I was too rushed to really enjoy the ride. Piloting the Jet Belt is more fun. It gives me lots of time for maneuvering, and I can fly relaxed. There is no perceptible vibration. The ride is smooth.

It may seem odd, but I have a comfortable feeling of security aloft with a flying belt. I actually feel safer than I do driving the family car in traffic. After seven years' first-hand experience with flying belts, I have a great deal of confidence in the system's reliability.

When I'm ready to land, I move the control arms upward to decelerate, set up a rate of descent, pick out my landing spot, and keep it in sight. I gradually brake the rate of descent until I'm almost hovering where I want to set down. Easing over to it, I can put myself down gently on a target a foot square.

After landing, I throttle down the engine to "flight idle" and walk to where I'm going to park the vehicle. Then I return the throttle to "ground idle." I put down the stand, shut off the engine, and get out

First came Rocket Belt — then, versions like Flying Chair and Pogo

of the harness, to become again an earthbound human like other men.

It's all quite simple. Anyone who really wants to learn to fly the Jet Belt should be able to do it in a few weeks.

Story behind Jet Belt spans 16 years. Both the Jet Belt and its predecessor, the Rocket Belt, were invented by Wendell F. Moore, Bell's assistant chief engineer. The Bell flying-belt story begins in 1953, when Moore first gave the idea serious thought. Research and development proceeded slowly, and the first manned free flight with the Rocket Belt was made on April 20, 1961. Pilot Harold Graham flew it for 13 seconds and to a distance of only 112 feet, not quite as far as the Wright brothers' first powered flight—but he made aviation history that day.

A 1960 development contract awarded Bell Aerosystems by the U.S. Army Transportation Research and Engineering Command had specified: "Build an SRLD [Small Rocket Lift Device] and demonstrate its feasibility in manned flight." And demonstrate it we did, to the Army and the world. In the years that followed the Rocket Belt's first trial, it proved its 100-percent reliability in more than 3,000 demonstration flights, witnessed by millions of people all over the globe.

As captain of a world-touring Bell Rocket Belt team, I've flown in most major U.S. cities, and in foreign countries on four continents. I demonstrated the Rocket Belt at the Tivoli in Copenhagen, at the Paris Air Show, at the first Super Bowl game in Los Angeles, and at the Royal Easter Show in Sydney. The 1964 New York World's Fair saw me rocketing around the Amphitheatre in Leonidoff's musical extravaganza, *Wonder World*. In Hollywood, I did the flying-belt sequences for the TV series, *Lost in Space*, and made several television commercials too. When I signed up to fly for Bell Aerosystems, I never thought they'd put me in show business, but it's been great fun.

All this flight experience established the Rocket Belt's feasibility.

[\[Continued on page 190\]](#)

Defense Department reveals Jet Belt data

Just as this issue goes to press, POPULAR SCIENCE has obtained from the Defense Department the actual figures for the Jet Belt's remarkable performance—figures still classified when this article was written, but now cleared to be made public. They are:

RANGE: 10 miles ENGINE THRUST: 430 pounds
SPEED: At least 60 m.p.h. ENGINE WEIGHT: 68 pounds

TOTAL EMPTY WEIGHT, including engine, belt, and subsystems (fuel tanks, parachute, two-way radio system, etc.): 126 pounds

TOTAL FLYING WEIGHT, including operator and clothing (180 pounds), fuel and oil (43 pounds), and telemetry: 365-367 pounds

SPECIFIC FUEL CONSUMPTION (fuel consumed hourly, per pound of weight flown): 0.70 pound

THE EDITORS

Test-pilot Courter flies Pogo, stand-up version of rocket-borne platform. "Body-controlled" type shown, steered just by leaning, made debut in 1968.



Rocket Belt, first of family, kicks up spray as it's flown over water. Its hydrogen peroxide propellant produces lifting blast of steam.



Flying Chair—a sit-down, platform-type version of Rocket Belt—is tried out by the author. First free flight with it was made in 1965.





Dr. Grosse and His Wonderful Bubble Machine

A vanishing act in 20 seconds occurs as the famed scientist demonstrates a significant feature of bubbles: They can isolate a man—or small group—from sight and sound rapidly, harmlessly, perhaps to save life. Standing in circular canvas wall, Dr. Grosse turned on a pump that produces bubbles through a flat plate with pinhole perforations. Swiftly he disappeared into a silent bubble world where he could not hear our shouts—from only 10 feet away—and we couldn't hear or see him. To breathe freely he simply pushed bubbles away from his face (air permeates space between bubbles). In his research, Dr. Grosse has created "permanent" bubbles from tiny shaving-soap size up to huge 10-foot balloons by using plastics. He has even colored them black.



Be the first on your block to blow an incredible new breed of bubble—permanent, plastic, and practical

By FRANK HARVEY

PHOTOS BY ORLANDO GUERRA AND HARRY SAMUELS

Dr. Aristid Grosse, a cherubic Santa Claus of a man who also happens to be a world-famous atomic scientist (he worked on the Manhattan Project), sits in his bosky laboratory off Philadelphia's Main Line and blows soap bubbles. Well, they are basically soap bubbles—but Dr. Grosse has sneaked some special chemicals into them, and that makes them the craziest and perhaps the most useful bubbles in the world.

Would you believe that a mass of bubbles could leave a blowing machine and rise, like a huge blob of seafoam, some 30,000 feet straight up? Dr. Grosse nonchalantly launches such blobs in his backyard to soar over the tree-tops, startling his neighbors no end.

Or would you believe that a bubble blown by Dr. Grosse today could still be glistening with an iridescent sheen a year from now—or maybe *two* years from now? Dr. Grosse blew one such bubble that was so large he had to take the door off the basement of his house to move it in.

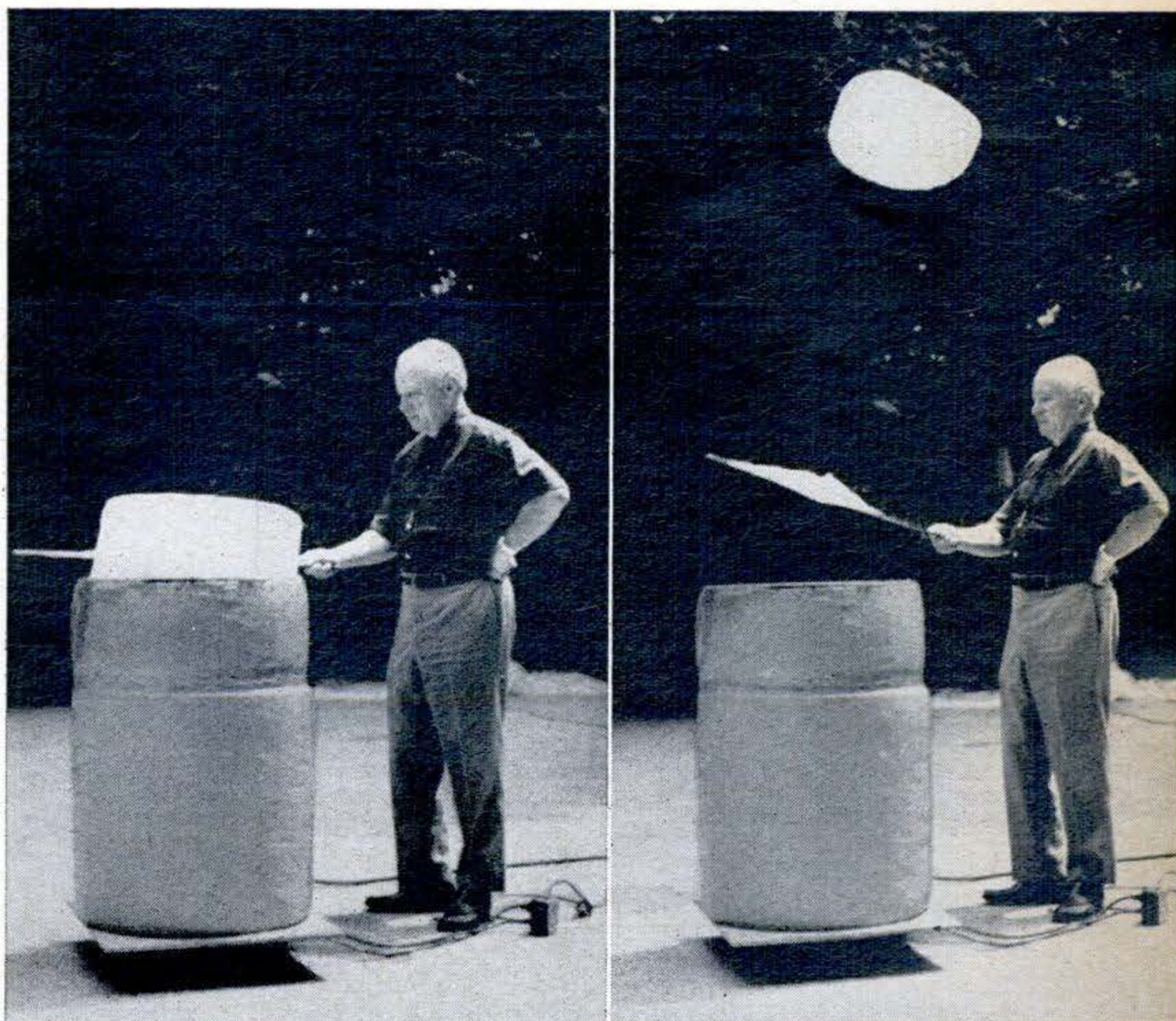
Or what would you say if somebody told you he could cool off a street disturbance by inundating the rioters with a mass of foamy bubbles whooshed out of a backpacked bubble machine? Dr. Grosse has already learned how it feels to be buried in bubbles—by being buried in them himself.

"You can't see a thing," he says. "You can't hear a person three feet away unless he shouts. The only way you can breathe

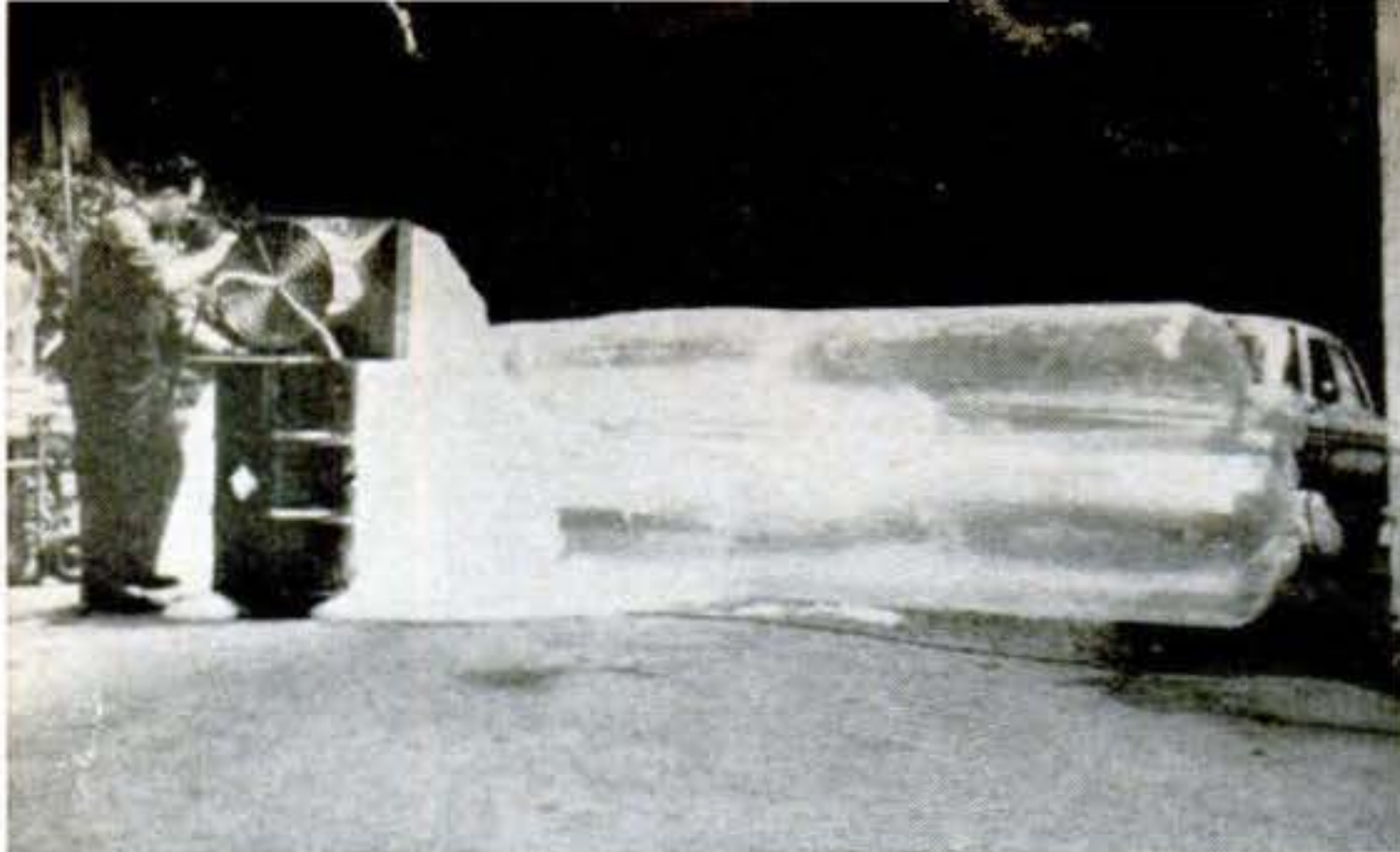
is to make a space in front of your nose with your hands. It really does cut down a man's riot potential rather effectively."

Bubbling serendipity. Dr. Grosse started blowing soap bubbles several years ago, in an effort to find a new wrinkle in the popular children's pastime. Then he hit on the idea of adding water-soluble synthetic organic polymers to the soap-and-water everybody had been using for centuries, and he came up with some very unusual bubbles.

He could make sticky ones, stiff ones, or slurpy soapy ones. He experimented with low temperatures, and found that he could cool a plastic bubble until it became



Dr. Grosse saws off a slab of "skyfoam"—a mass of bubbles manufactured in his simple machine, a coil of copper tubing with perforations placed in the bottom of an ordinary oil drum and fed by a cylinder of commercial helium. These buoyant blobs, formed from Dr. Grosse's own solution, float off to rise as high as thousands of feet before they are finally deflated by shrinkage and the loss of helium.



An "instant roadblock" spews from the bubble machine

In a simulated roadblock at the research lab, Dr. Grosse's assistants use two huge plastic bags as a foundation, then inundate them chest-high in seconds with foam from the bubble-belcher. The

plastic base would be dispensed with in an actual situation, and the barrier made of all foam. Cheap, harmless, and quick, the barrier of bubbles might prove a gentle but effective form of crowd control.

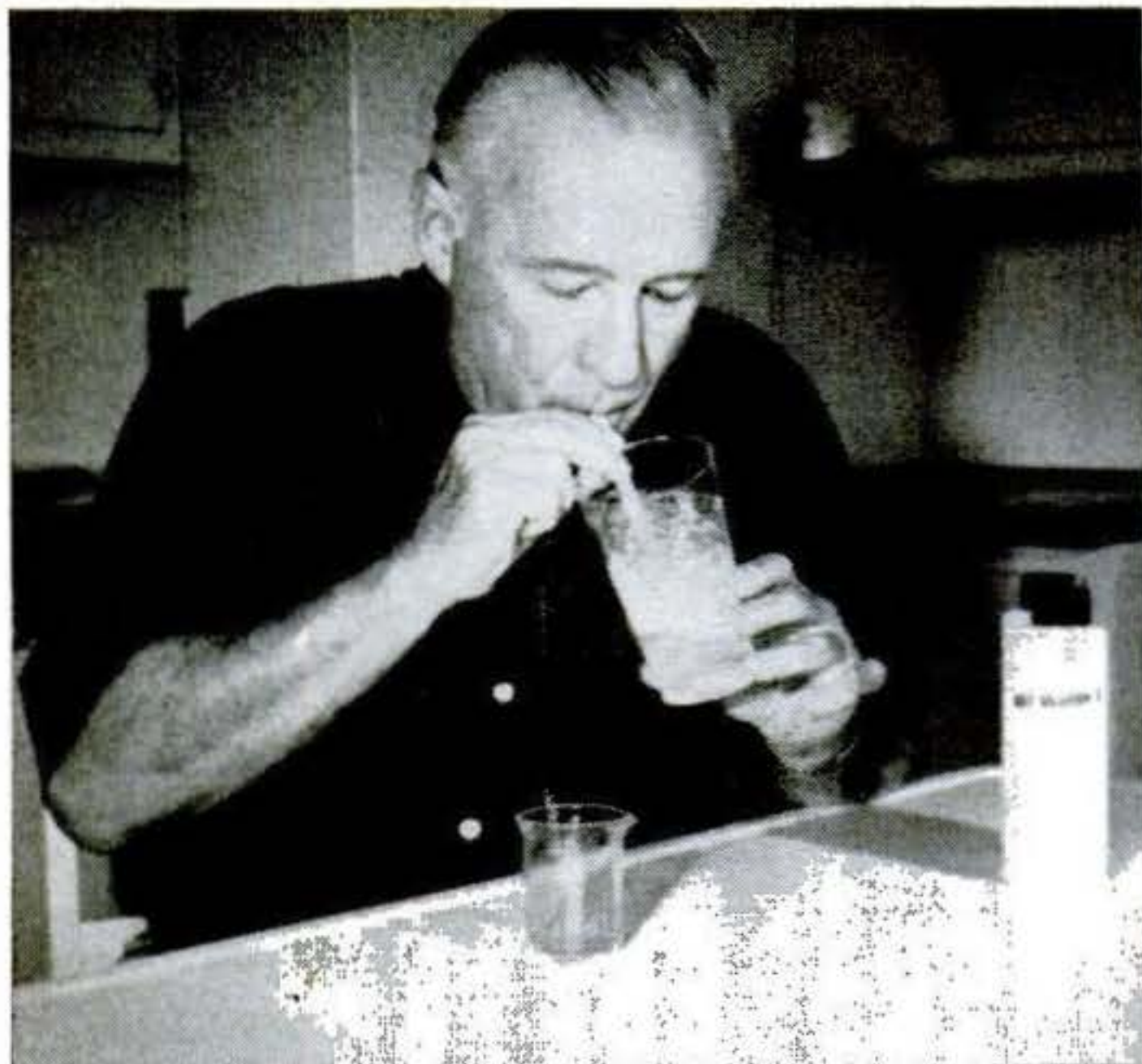
as tough as a balloon—and even to the point where it solidified! By keeping his bubbles protected inside glass containers, where no dust or air currents could ruffle them, he found he could sustain their lives for hours, weeks, months, and even years.

He then proceeded to produce bubbles in a whole rainbow of gorgeous colors—baby blue, lipstick pink, glowing orange—and then spangled them with glittering sequins. He is now developing an idea for hot-dog-shaped bubbles 40 feet long, to be used in shows, fairs, parades, and anywhere else fancy suggests.

Bugging bugs with bubbles. He is also experimenting with bug control via bubbles. The plan is to surround the insects—on trees or plants—with clots of tiny, dense bubbles. These will smother the creatures without contaminating the vicinity with deadly bug dusts.

Dr. Grosse is his own best booster. He talks like a born sweeper salesman, has an idea a minute, some a good deal more fanciful than others. He has produced "foam-earth"—a concoction that looks just like solid ground but that squishes into dust under pressure—which he claims

... Dr. Grosse demonstrates his bubbling techniques.....



Blowing through a straw into a special liquid compounded of two basic ingredients (Keuhner's Solution of dibromostearate soap . . . plus a mixture of polyvinyl alcohol, water, and glycerine) Dr. Grosse here demonstrates how you can produce long-lasting foam in any tall glass. The special solution may

be purchased readymade from the Techno-Scientific Co., P.O. Box 191, Baldwin, N.Y. 11510, for around \$4 a pint. A pint is enough to make many thousands of bubbles. Next, Dr. Grosse pours a little of his special mixture into a flat dish in preparation for blowing a big bubble with the glass blow-

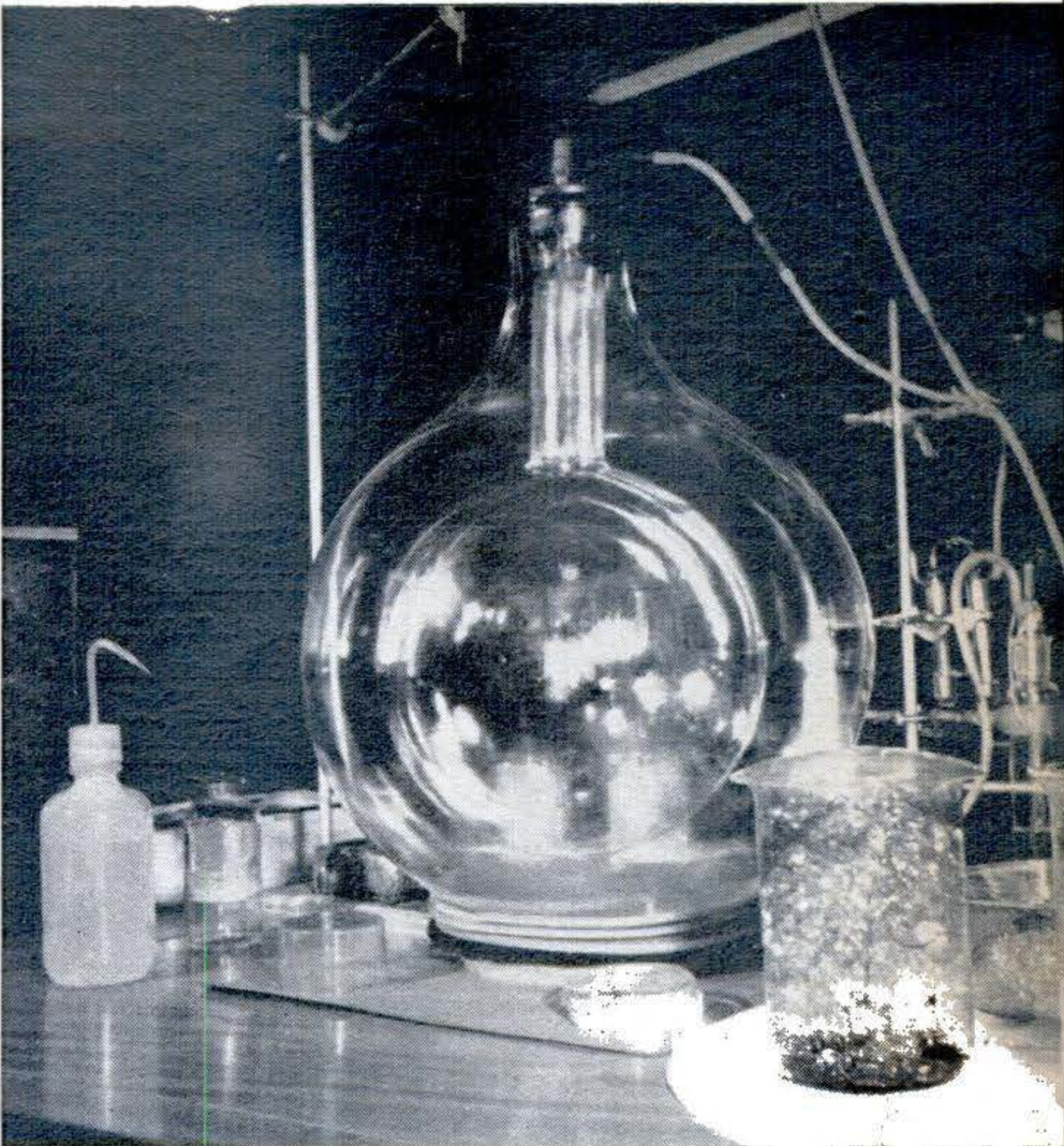
would be fine for covering a booby trap. It probably would.

But when he suggests that a good way to protect a jungle village from guerilla attack is to surround it with a huge circle of bubbles, he might find critics who would find his idea lacked substance.

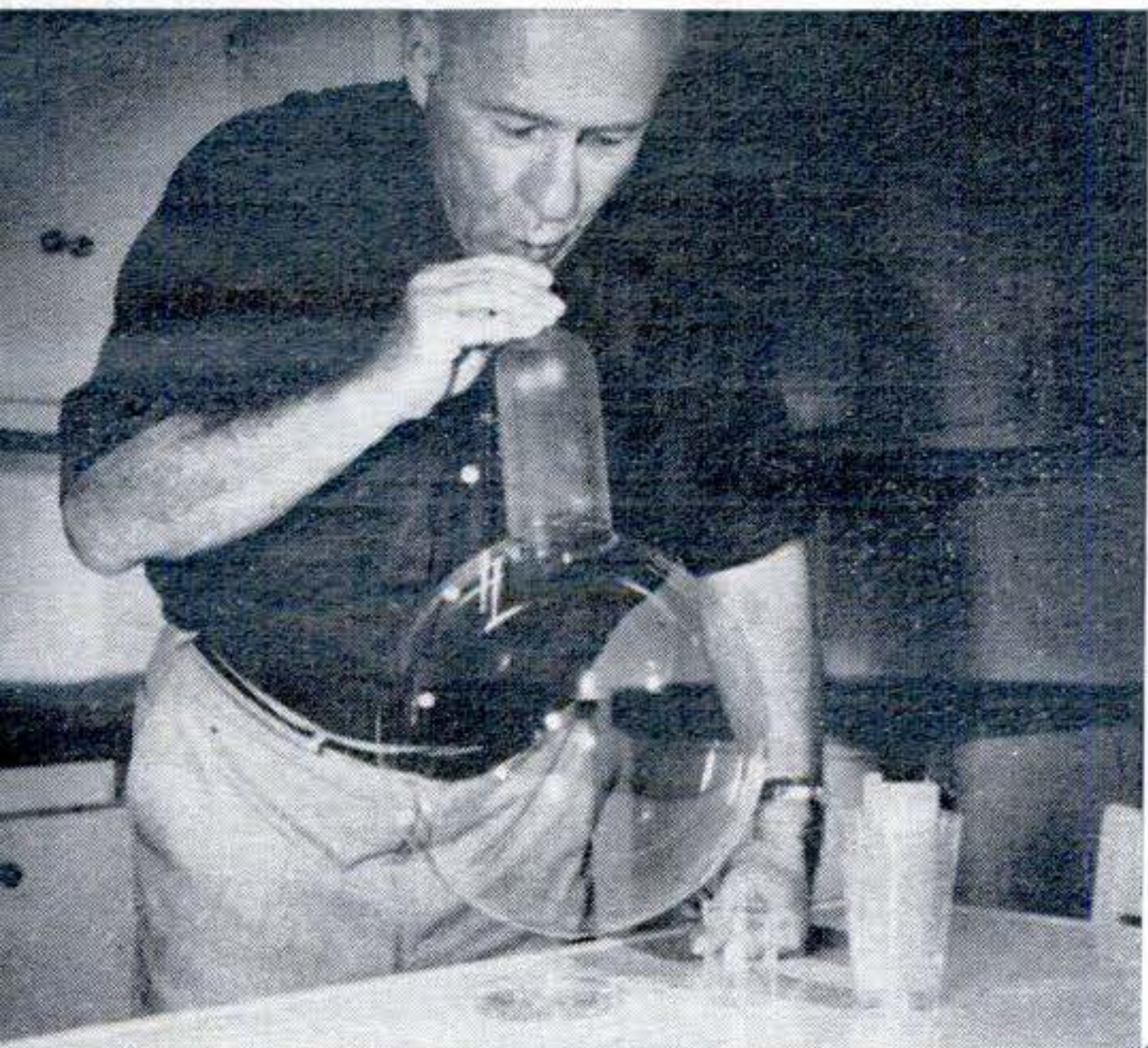
In any event, the impact Dr. Grosse has made is very solid—more so than even his firmest bubbles. He’s been seen on TV, heard on the radio, and reported in newspapers and wire services. A substantial number of hardheaded businessmen have sought out Dr. Grosse with the idea of producing his bubbles commercially for various uses.

His secluded laboratory, which seems to have once been the home of a super-rich tycoon of the 90’s, is becoming a port of call for interested parties from far and near, and the good doctor and his pretty secretary have more or less stopped experimenting and concentrated on answering questions. Amazingly, Dr. Grosse finds time to fit all this around his professorial duties at Temple University in Philadelphia.

One thing is pretty certain: Dr. Grosse has hit on an idea that can be used in a great variety of ways, from en-



“Dust is the archenemy of bubbles, particularly if the dust contains crystals of salt,” Dr. Grosse explains. Therefore, in order to preserve his fragile creations for years, the scientist has them carefully blown inside an airtight dust-free bottle, as shown above. Created under such protection in his laboratory, the bubble may well last indefinitely.



pipe on the table (you can make such a pipe by removing the bottom of any bottle). Finally, Dr. Grosse blows a bubble (above) which, unless it is disturbed by air currents or a foreign object, may last for 20 years. Bubble fans can make their own bubbles, similar to this one, in their own homes.

tertaining children (and their parents) to floating jet planes that have to ditch in mid-ocean.

You, too, can blow a Grosse bubble. All you need is a water glass, a tube, some soap and water, a little of the special additive (such as polyvinyl alcohol, Plasdone C, or polyox)—and some lung power.

Dr. Grosse has developed a simple solution, which he calls “double bubble.” You can buy its ingredients (see photo caption in box) in any good drugstore, and the field is open to all. “Double Bubble” bubbles gel in a day or so, and become tough and nonshrinkable, like toy balloons. Add a little color and a few sequins and *voila* a thing of shimmering beauty. Add a little helium, and they float high in the sky, to startle captains of Boeing 707’s cruising at 30,000 feet.

It’s not expensive, it’s fun, and if you can think up some new commercial use for these exciting permanent bubbles, it could even be profitable.

PS

What Goes On Inside

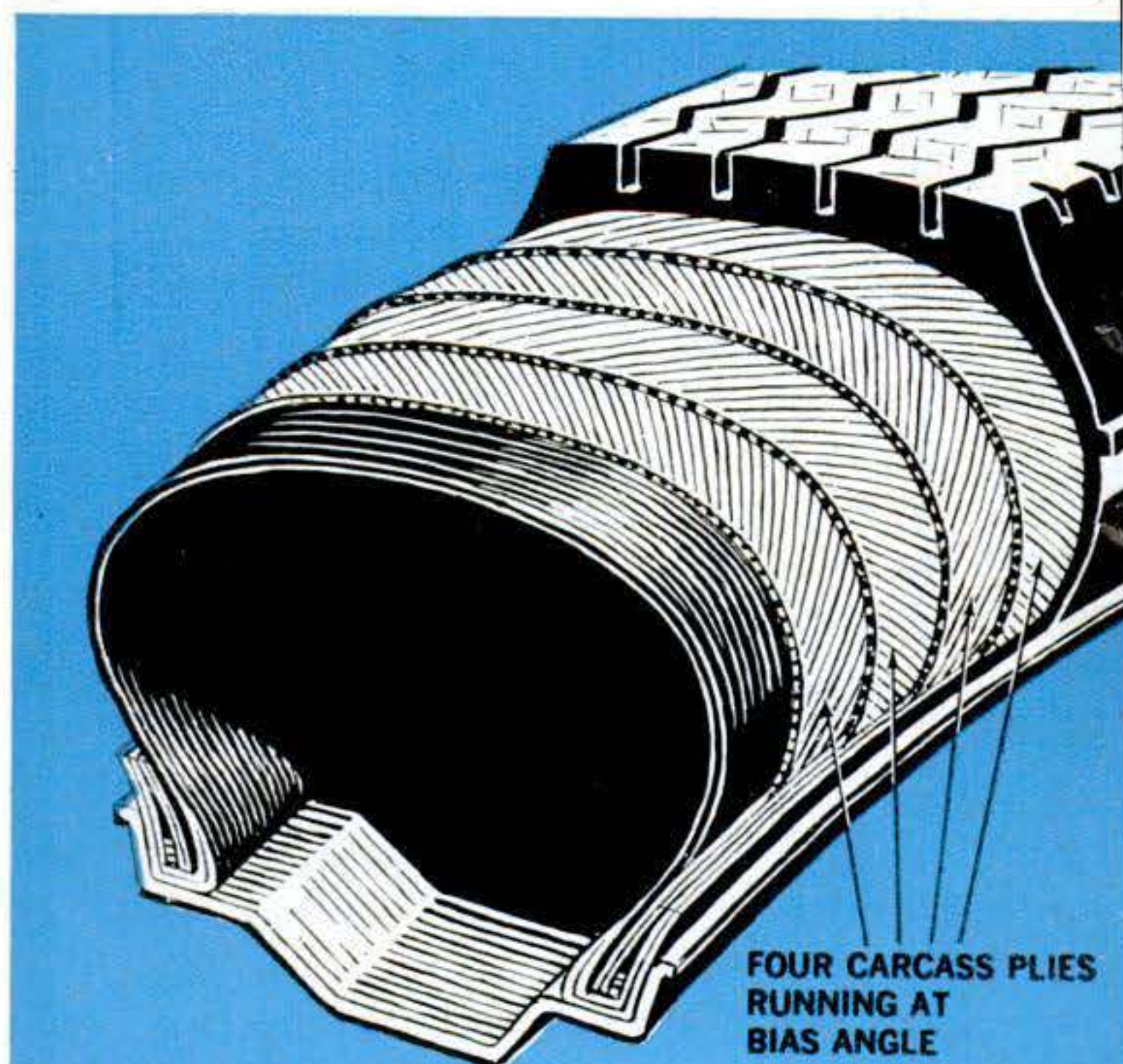
As your car rolls along, the tire is forever changing shape, on straightaways as well as curves

When you buy your '70 car, you'll get tires that are radically different from any previous original-equipment tires for American passenger cars. Instead of the much-maligned two-ply tires of the '60s, your '70 car will have fiberglass belted tires (unless you get a Thunderbird or a Continental Mark III, which have radial-ply tires). The new tires will give longer tread life, improved traction, and better handling. How do these new tires differ in construction from conventional tires?

The radial-ply tire shown here has six plies under the tread and two plies in the sidewalls. These two sidewall plies are stretched radially around the tire—not crisscrossing as in conventional and fiberglass-belted tires.

What goes on inside your tires depends mainly on the tire's inner construction, and less on inflation pressure (within limits), tread width and rim width, or its aspect ratio (that's the width-to-height relationship of the tire profile).

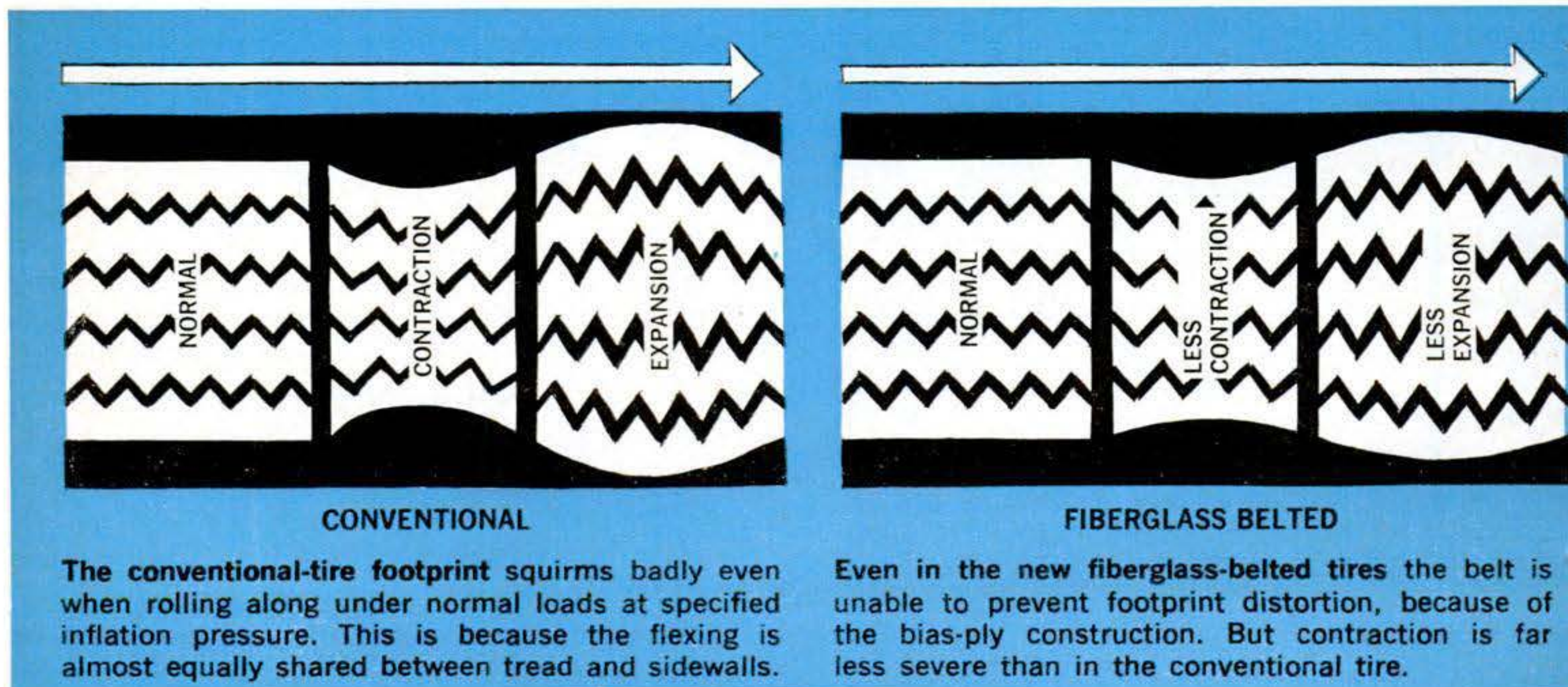
As you can see from the chart on a following page, tire designations have undergone a complete revolution. The new tires do not carry any indication of bead-to-



Conventional four-ply tire has four cord plies in the carcass, but no belt plies. The plies crisscross at about 45 degrees to the centerline of the tread, and provide equal flexibility in the sidewalls and under the tread. Only the tread pattern, its depth, and the shoulder design define the actual tread.

bead width, as in the good old 6.00-16 tire. Instead, your new tire may say F78-15. The designation F is the tire load capacity, on a scale going from A to L. The number 78 is the aspect ratio, and 15 is, as before, the tire's bead diameter.

The tire designation FR70-15 indicates

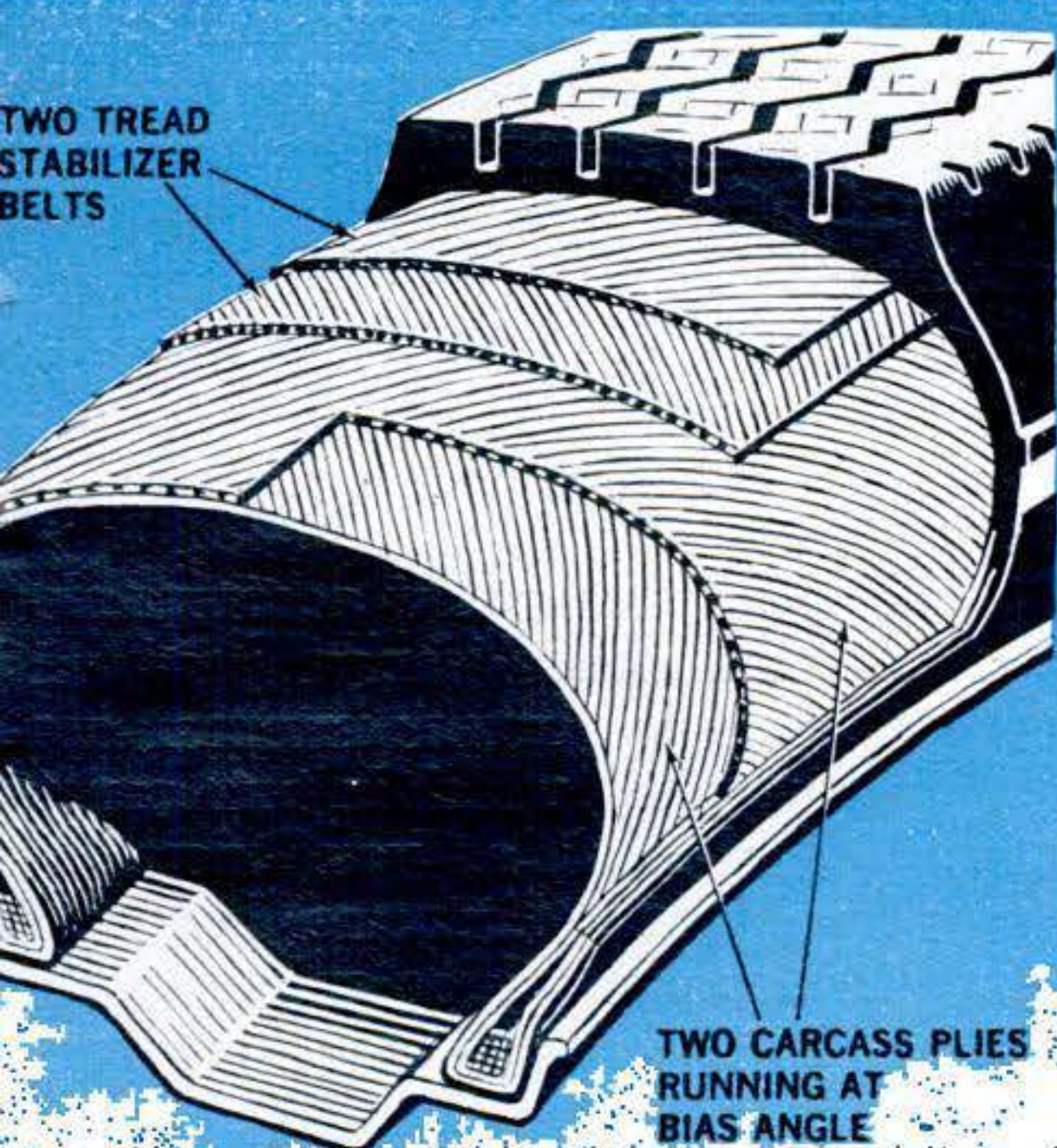


The conventional-tire footprint squirms badly even when rolling along under normal loads at specified inflation pressure. This is because the flexing is almost equally shared between tread and sidewalls.

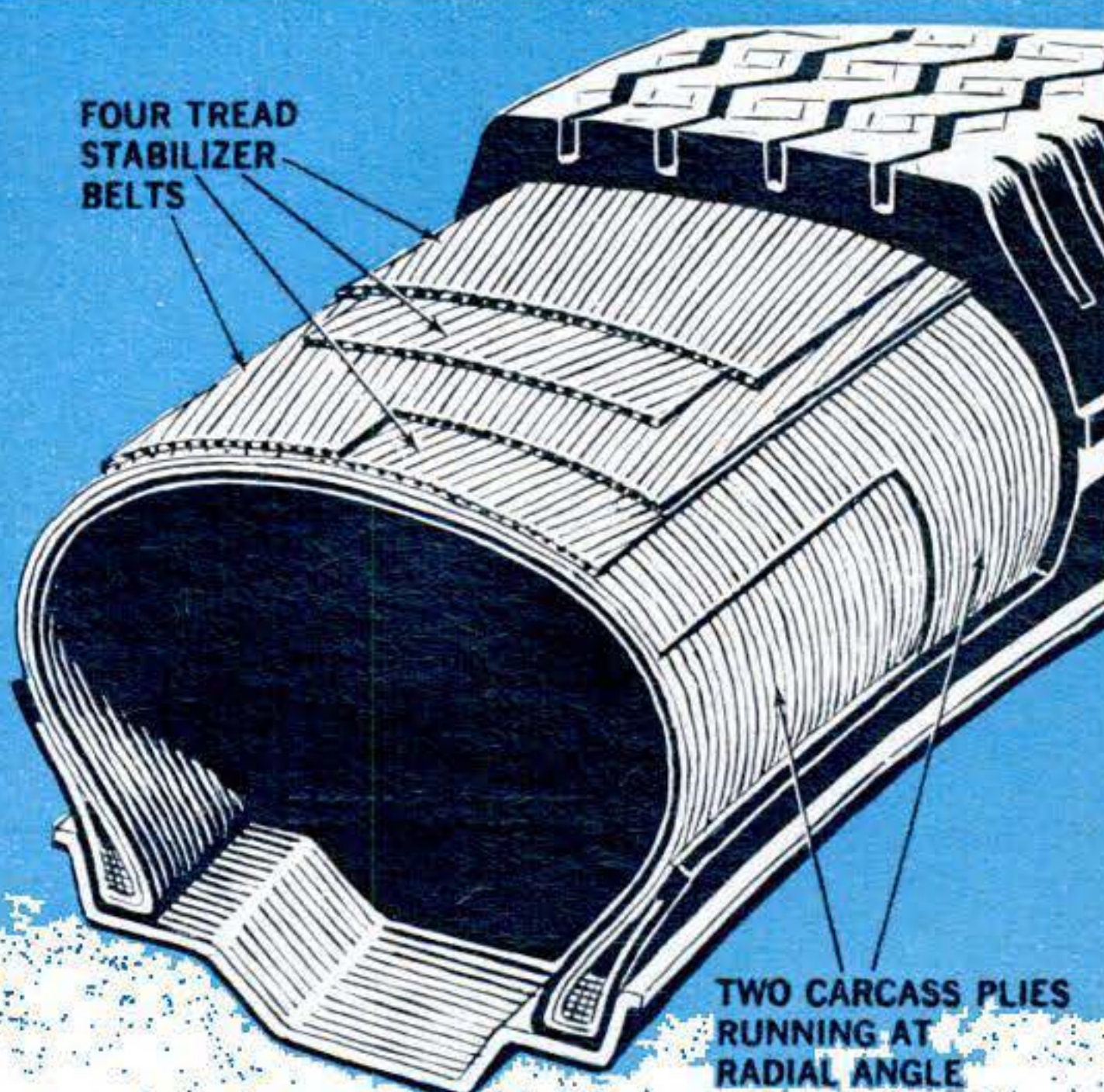
Even in the new fiberglass-belted tires the belt is unable to prevent footprint distortion, because of the bias-ply construction. But contraction is far less severe than in the conventional tire.

Your TIRES ?

By JAN P. NORBYE / PS Automotive Editor



Today's original-equipment tires have two carcass plies that crisscross in conventional fashion (bias-ply) plus two fiberglass belt plies under the tread. The belt is inextensible and assures long tread life. It also adds extra protection against road hazards (broken glass, tin cans, nails).



Radial-ply tire has no crisscrossing carcass plies. All cord plies run straight from bead to bead. Four belt plies (ranging from rayon to steel, according to make and type) assure optimum tread stability. The radial-ply design allows tire's sidewalls to flex freely, practically without internal friction.

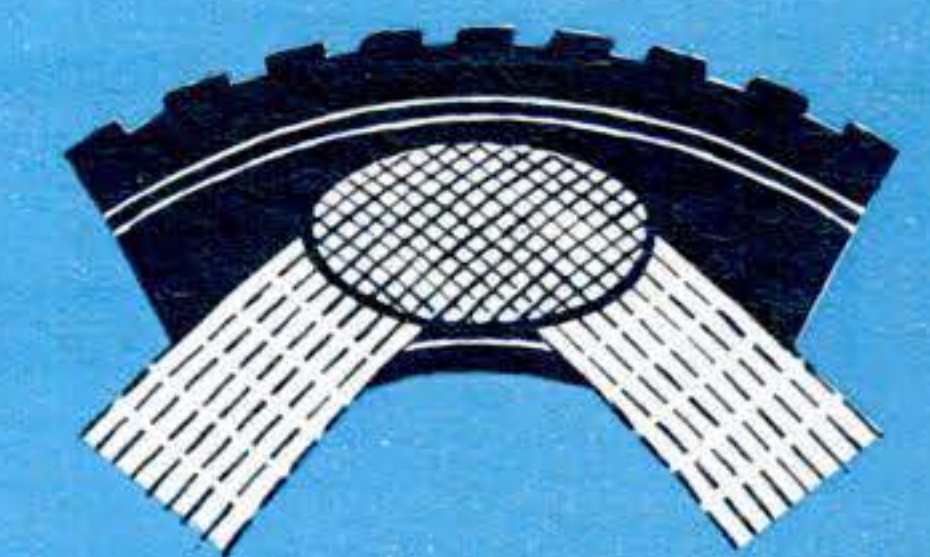
the same diameter and load capacity, plus radial-ply construction, and a lower aspect ratio.

The chart indicates which tire sizes correspond. For instance, if your car now has worn-out 7.35-15 tires, and you want to replace them with radials, the size you want

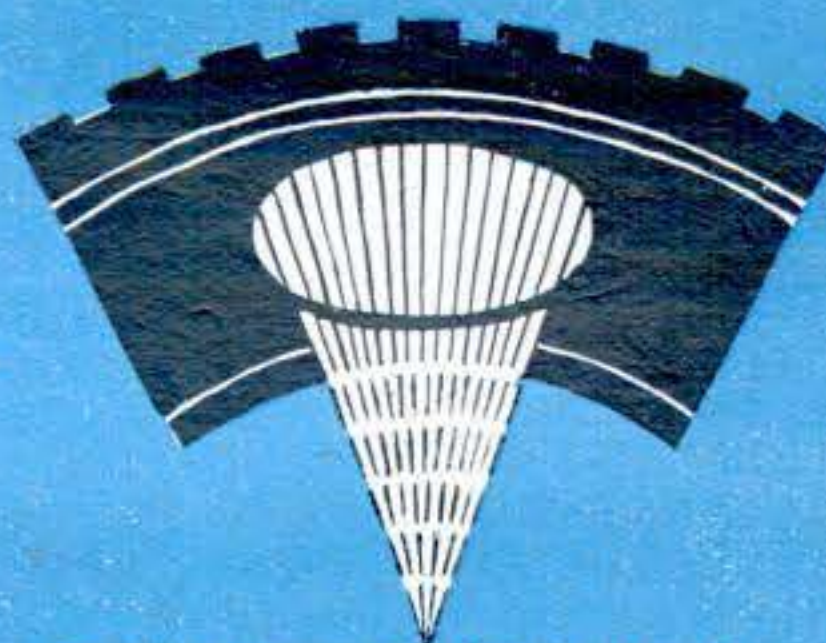


RADIAL

In the radial-ply tire, the sidewalls perform all the necessary flexing without disturbing the footprint. Contraction and expansion are of negligible proportions, even with a longer footprint.

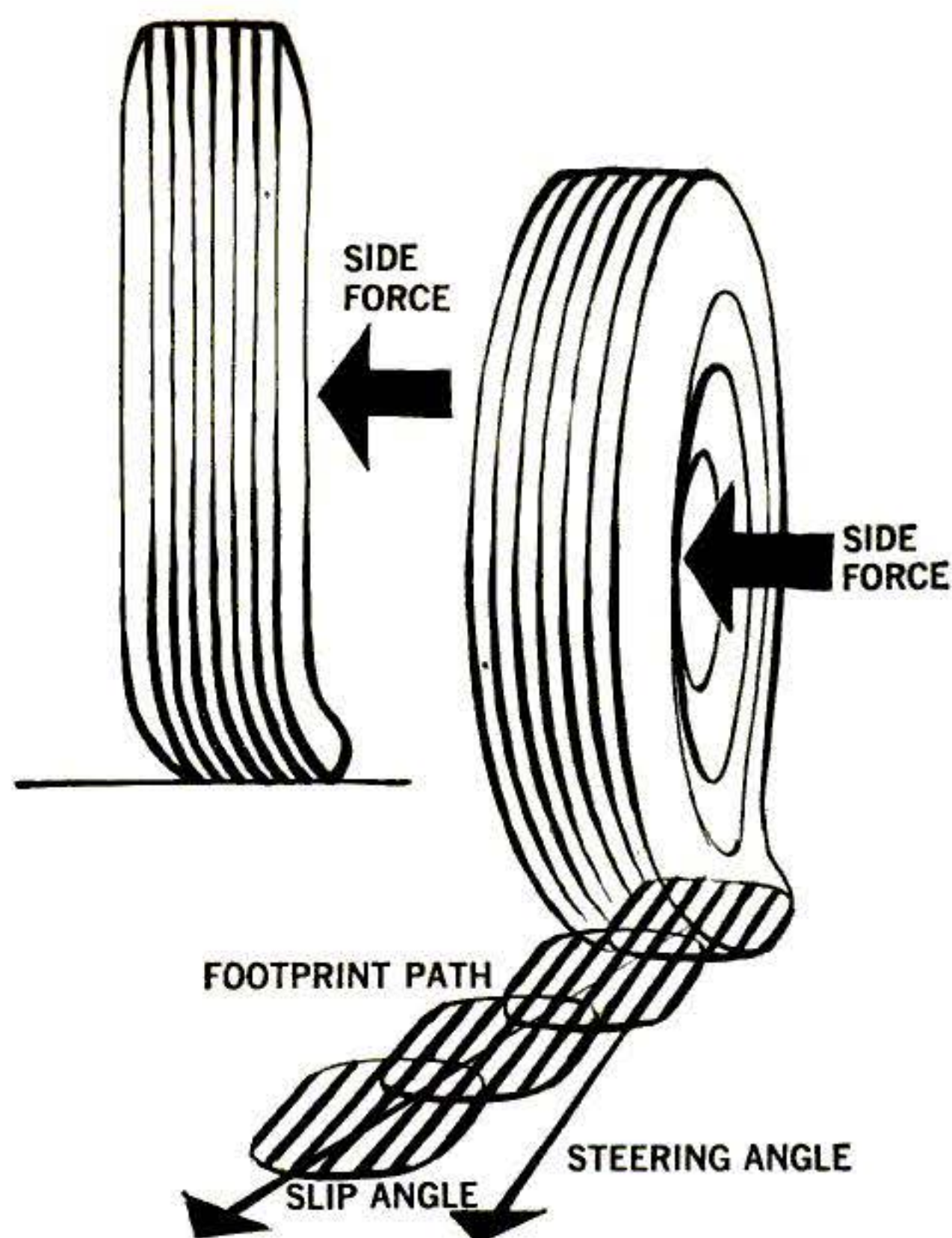


BIAS-ANGLE CARCASS PLIES CRISSCROSS



RADIAL PLIES RUN STRAIGHT

The crisscrossing carcass plies of conventional and bias-belted tires mean that the plies will be fighting each other every revolution of the wheel. This internal friction generates heat—a major cause of tire failure. The radial-ply tire runs much cooler, since cord plies are not in conflict.



Any time a side force is exerted on your car, the tires run with a certain slip angle. That's the angle between the line the tire is aimed on and the line it is actually following. The footprint is progressively moved from its intended path by side force.

is 185R-15. Puzzled by the "185" figure? That's tire width indicated in millimeters.

The drawings show the differences in footprint distortion on both straightaways and curves. When you examine them, you will see that the fiberglass-belted bias-ply

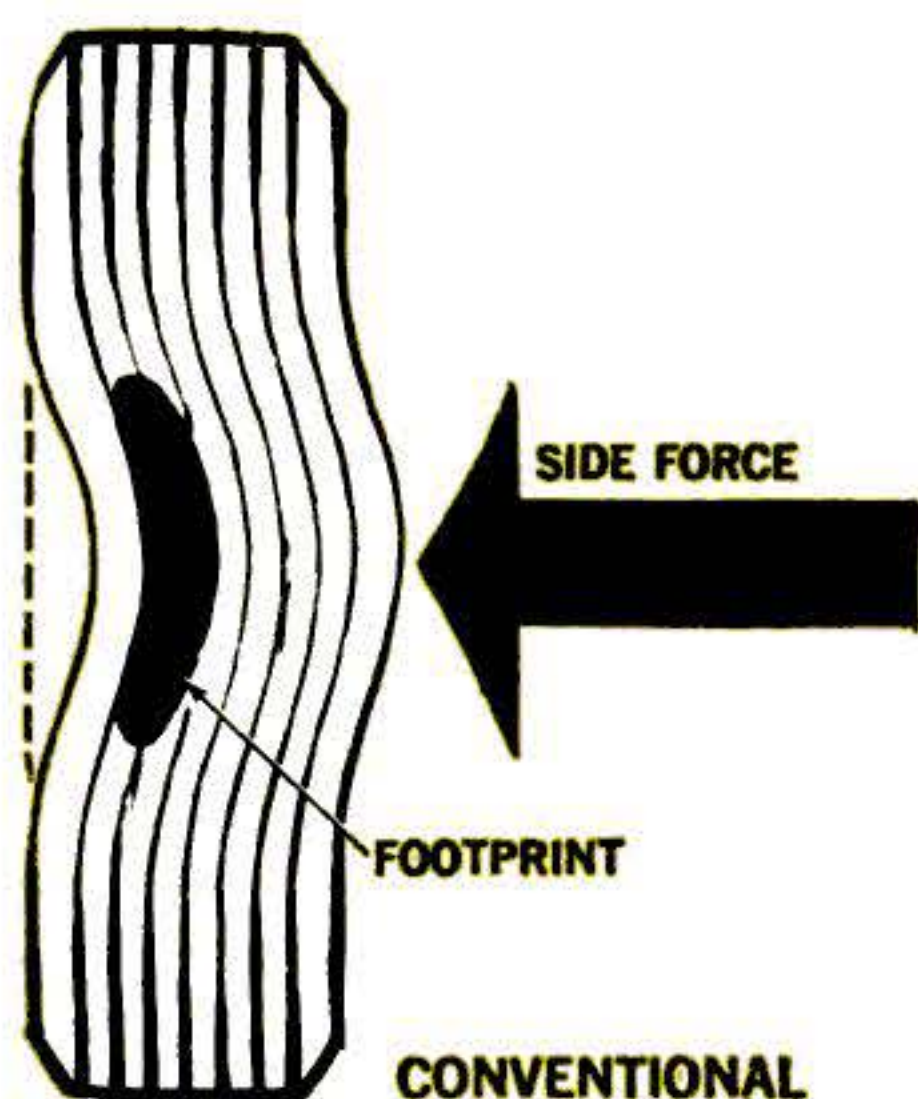
tire is a compromise solution to common tire problems, representing a middle stage between the conventional and the radial tire designs.

There are dangers. How harmful is footprint contraction as you go down the highway? In dry weather, the constant scrubbing wears out the tread faster. In wet weather, the contraction of the ribs closes up the evacuation paths for the water on the roadway and reduces your stopping ability and traction. If the layer of water is thick enough, the tire will hydroplane, which means it loses all contact with the road surface.

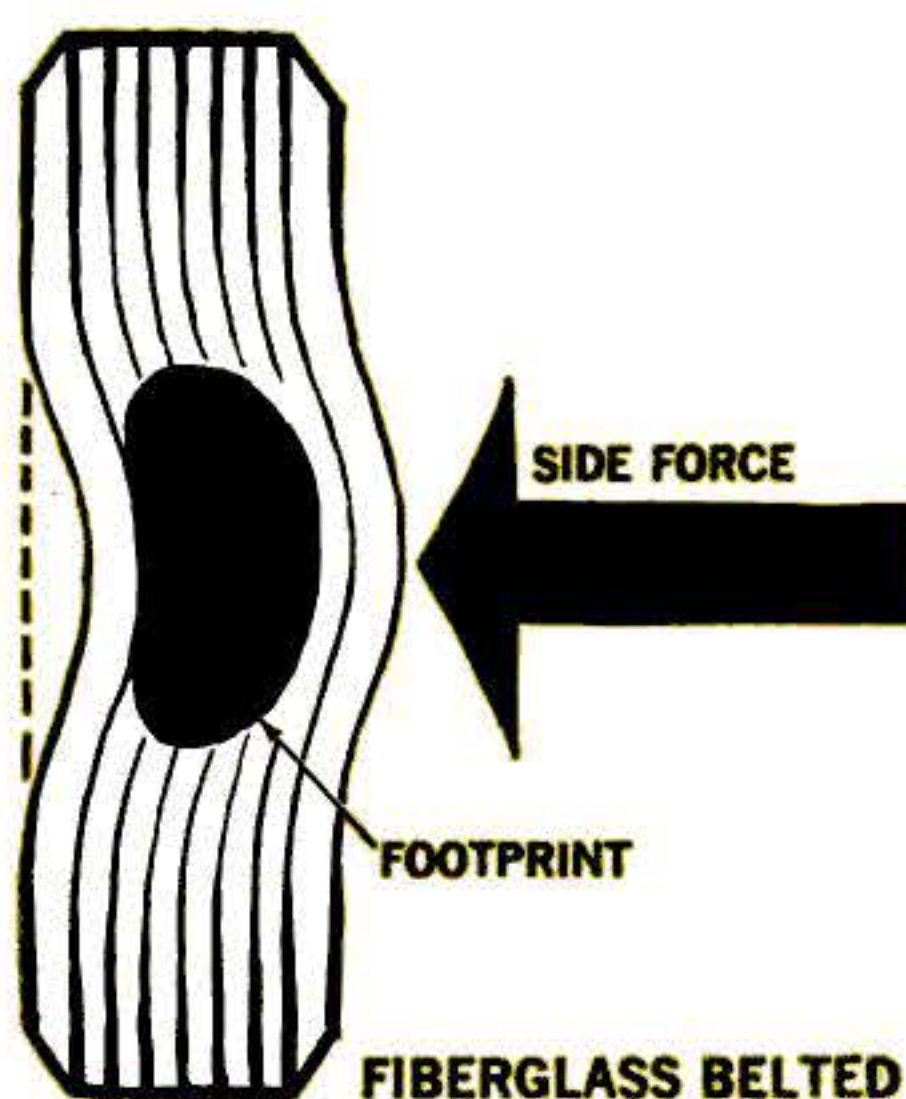
The sidewall flexing that accompanies each turn of the wheel (carrying its part of the car's weight) causes internal friction in the cord plies, which in turn generates heat. And heat, as you know, accelerates tire wear. Extreme heat can cause tread separation, or splits in the cord plies. In both cases, you have total tire failure.

In the fiberglass-belted tire, some of the squirm has been taken out of the tread without adding any flexing strength to the sidewalls. It's a stiffer tire, but there is still a certain amount of internal friction between cross plies as the wheel rolls down the road.

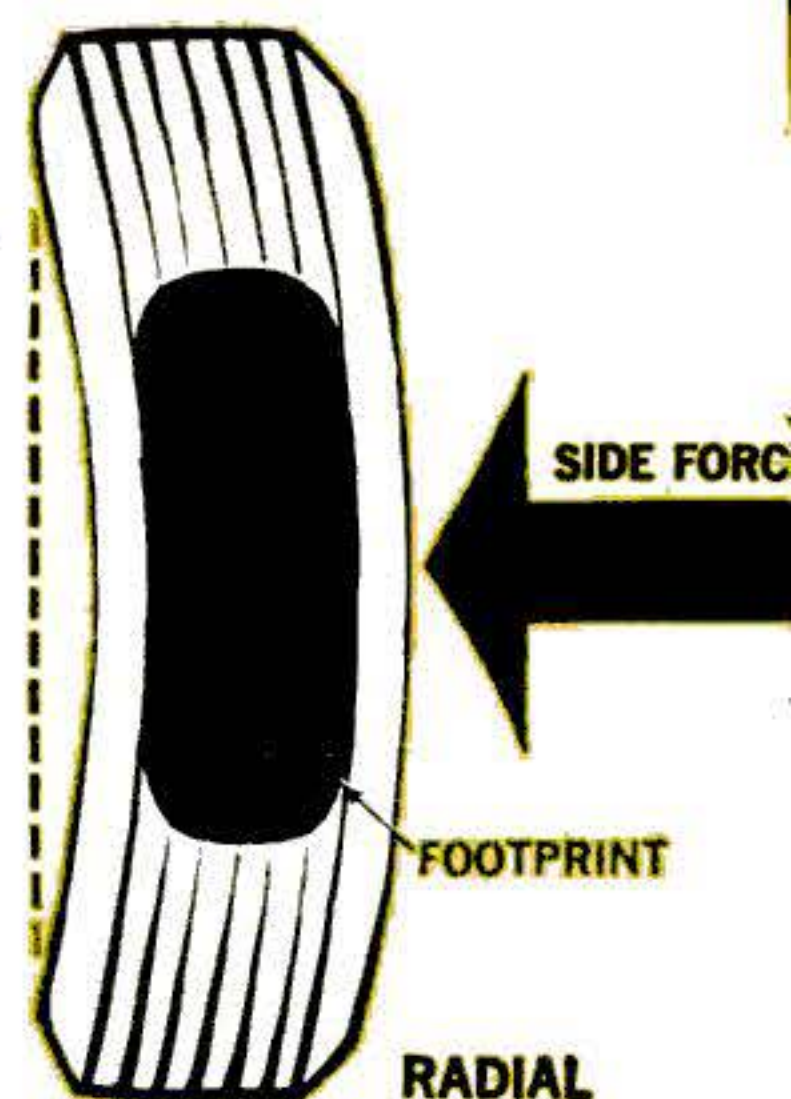
Internal friction is reduced to a minimum in the radial-ply tire, which also has



A strong side force will not only deflect a conventional tire but also lift part of the tread so that the footprint width is severely reduced. The result is loss of traction and undue wear on the smaller footprint area.



In the fiberglass-belted tire, the footprint retains more of its original width, but even so, the carcass is bent badly out of shape in a restricted area because of the sidewalls' greater resistance to flex under load variations.



Radial-ply tire keeps its full tread width on the roadway under a side load. The sidewall flexing is widely distributed around full circumference and, as when rolling straight, has a longer footprint.

a longer footprint and less contraction than bias-ply tires.

If radials are so great, why aren't they standard on the Detroit cars? For several reasons.

- They cannot be made on the same machinery that produces bias-ply tires.

- Akron just could not make enough of them. For the radial has about three times the number of components, and requires high-precision manufacture and assembly.

- It is inherently a more expensive tire, weighting the car's price tag.

- And Detroit also hesitates to push for radials because their different flexing characteristics call for retuning of the suspension system on the car if a quiet low-speed rough-surface ride is to be retained. And that is very desirable. But at high speed, radials are quieter, with or without suspension tuning.

The conventional four-ply aftermarket tire will, of course, continue in production.

Don't mix 'em up. No matter what type of tire you get, remember not to mix conventional tires with fiberglass-belted or radials on the same car. If you do, you'll lose steering precision, and risk unpredictable handling characteristics. If you put snow tires on the rear wheels, they should be of the same type as those on the front wheels.

It's particularly important to note that radials should always be used in sets of four. Under no circumstances should radials be used on the front wheels only. Radial snow tires are in production by all major tire makers. Of course, some radials with highway tread give you the same traction in snow and ice as pure snow tires. That's because there is such a negligible contraction in the footprint.

What would you have to pay for a set of radials? Almost twice the price of 1969 OE or 100-level tires of corresponding size. The

fiberglass-belted tires sell for about 50 percent more than conventional tires, currently.

And which tire will give you the longest tread life? Let me answer it this way: Some radials are *guaranteed* for 40,000 miles. Radials only. PS

TIRE SIZE OR DESIGNATION						
Conventional Bias Ply	Other					
	Replaces 1965-On	Bias and Belted Bias Ply "78 Series" "70 Series" "60 Series"	Radial Ply "80 Series" "70 Series"			
6.00-13		A78-13		165 R 13		
6.50-13		B78-13		175 R 13		
		C78-13				
7.00-13			D70-13	185 R 13		
				195 R 13		
6.45-14		B78-14		155 R 14		
	6.00-14			165 R 14		
6.95-14		C78-14		175 R 14		
	6.50-14					
		D78 14	D70-14		DR 70-14	
7.35-14				185 R 14		
	7.00-14	E78-14	E70-14		ER 70-14	
7.75-14				195 R 14		
	7.50-14	F78-14	F70-14		FR 70-14	
8.25-14				205 R 14		
	8.00-14	G78-14	G70-14		GR 70-14	
8.55-14				215 R 14		
	8.50-14	H78-14	H70-14		HR 70-14	
8.85-14		J78-14	J70-14	225 R 14	JR 70-14	
	9.00-14					
	9.50-14				LR 70-14	
G77-14						
				165 R 15		
6.00-15						
6.85-15		C78-15	C70-15	175 R 15	CR 70-15	
	6.50-15					
		D78-15	D70-15		DR 70 15	
7.35-15		E78-15	E70-15	E60-15	185 R 15	ER 70-15
7.75-15					195 R 15	
	6.70-15	F78-15	F70-15	F60-15		FR 70-15
8.15-15					205 R 15	
	7.10-15	G78-15	G70-15	G60-15		GR 70-15
8.25-15						
8.45-15					215 R 15	
	7.60-15	H78-15	H70-15			HR 70-15
8.55-15						
8.85-15					225 R 15	
	8.00-15	J78-15	J70-15			JR 70-15
9.00-15						
	8.20-15		K70-15			KR 70-15
9.15-15		L78-15	L70-15		235 R 15	LR 70-15
8.90-15						
6.00-16						
6.50-16						
7.00-15						
7.00-16						



New CHARGER Spurs

High-speed charger repowers nickel-cadmium cells fast, may be breakthrough you've waited for

By JIM DAVIS

A small black box, about the size of an electric shaver, promises a new age of cordless power convenience for all the battery-operated devices you own.

I recently tried this new gadget, which recharges sealed nickel-cadmium batteries as much as 100 times faster than previous methods. I plugged a completely run-down nickel-cadmium powerpack for a searchlight into the black box, which in turn was plugged into a standard wall socket. I let it charge for 10 minutes and then turned on the searchlight. More than 25 minutes later, the light was still burning brightly.

The black box is a new development of the McCulloch Corp. (1601 W. Century Blvd., Los Angeles 90045). It is particu-

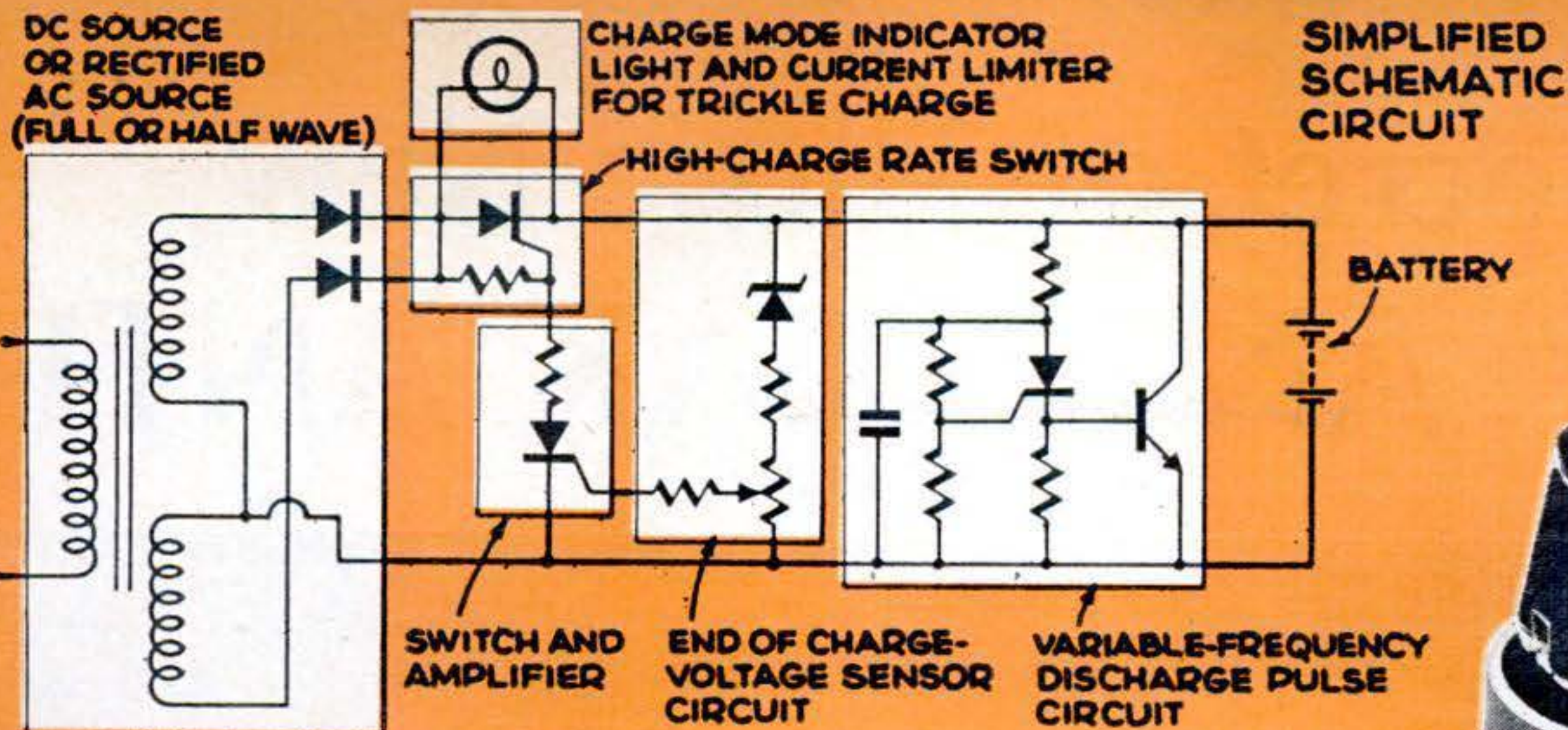
larly significant because sealed nickel-cadmium batteries have always been difficult to control under rapid charge.

McCulloch will license other companies interested in commercial application of the system. Honeywell is the first licensee—with exclusive rights to market it in the photographic field. Their first product utilizing the fast charger is a strobe.

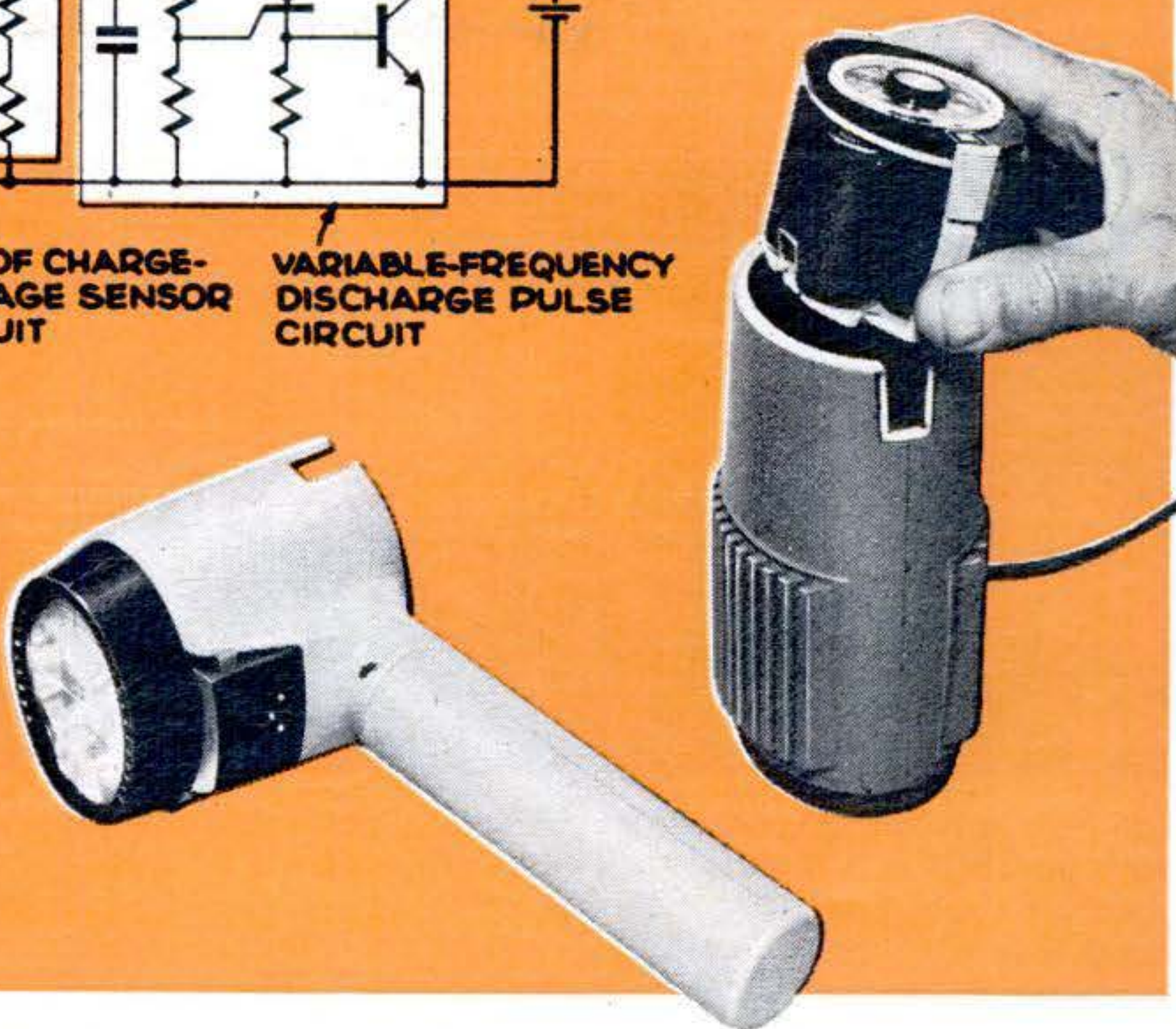
A photographer always had to wait as long as 18 hours to bring a strobe up to full charge. Some photographers keep a couple on charge constantly to be sure of a hot one when they need it. Now the black box for the Honeywell Strobolar 70 and Auto-Strobolar 770 does the job in 10 to 15 minutes, and costs about \$40.

How the charger works. The McCulloch system consists of three elements: the pulsing charge, a sensor that determines full charge in the cell, and a system to apply brief reverse current pulses to the plates.

The rapid charger sends a series of high-current pulses to the battery and



McCulloch fast charger may revolutionize gamut of products at left, is now available as Honeywell accessory for strobe lights (right). Simplified circuit diagram shows how black box uses DC or rectified AC source to recharge nickel-cadmium batteries. End of charge voltage-sensor circuit determines when cell reaches full charge. Variable-frequency discharge pulse circuit applies brief reverse current to battery so it can keep accepting high charge rate.



Cordless Revolution

then sends reverse-current pulses to produce changes at the plate surfaces to condition the plates so that they will continue to accept additional high-current charging pulses.

In most other systems, current is applied to the cell, electrochemically converting the plates into dissimilar elements that produce electric current when connected to a load. These reactions, especially at high charge rates, cause layers of gas, and other products of polarization, to form on the plate surfaces. These damage the batteries.

Previously, the only solution has been to charge these sealed batteries slowly, so that all the gases released could be absorbed internally in the cell.

It is theoretically impossible to ruin a ni-cad battery, but after much use they become sluggish and will self-discharge. They often refuse to hold a charge because they develop a "memory" that makes them incapable of accepting a full charge. The McCulloch system overcomes many of these shortcomings, and will ac-

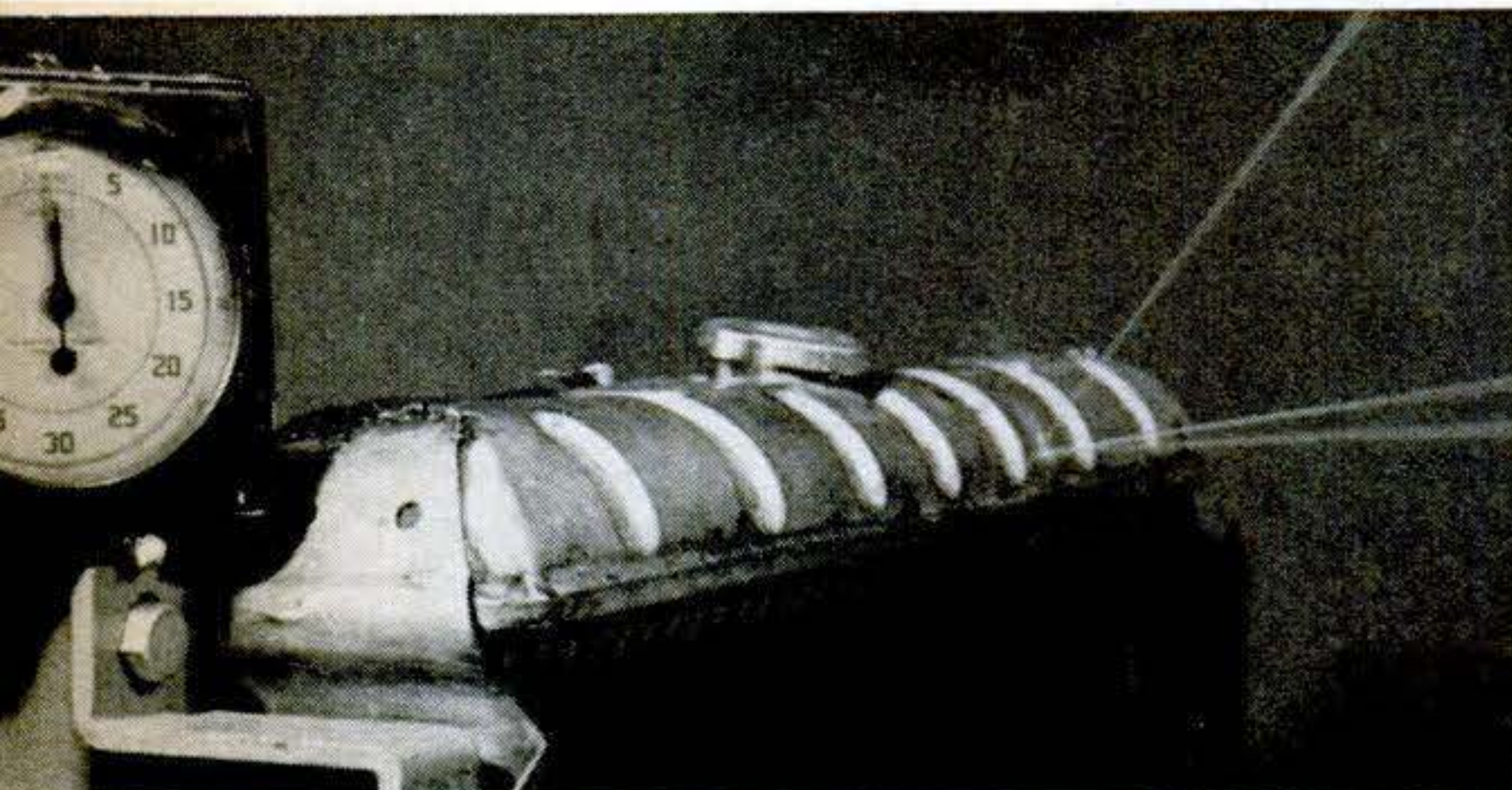
tually rejuvenate the sluggish battery.

Count the applications. The system won't be limited to the photo buff. Just stop and think about how many batteries you have in the house, and you'll realize what this system may mean.

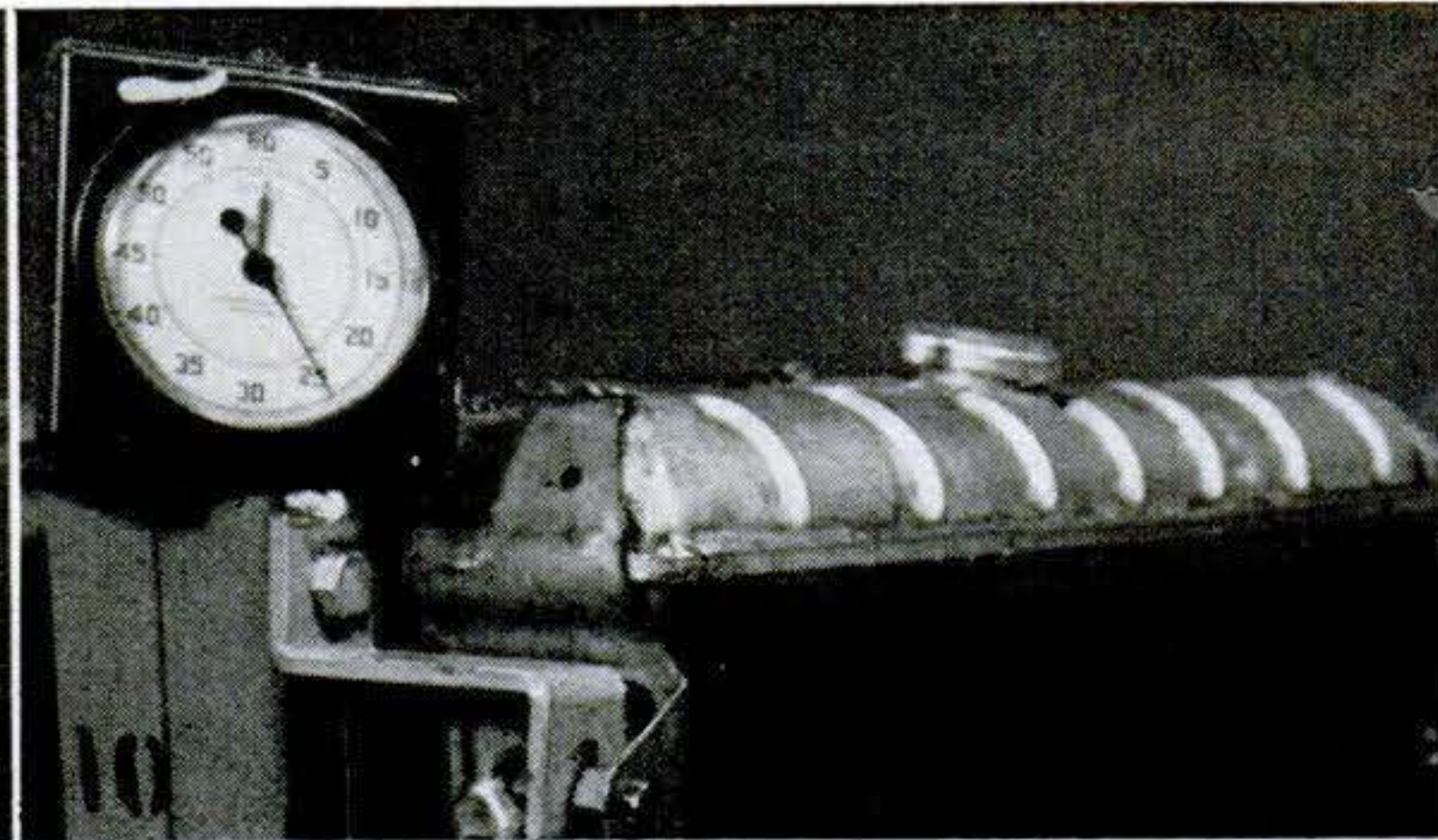
No longer will the children's battery-powered toys go on the blink after an hour's use. Nor will that portable TV that relies on batteries for its power go dead while you're watching the most exciting play of the year's big game.

The rapid charger could also speed the development of electric cars. The McCulloch black box would make it possible to set up "dial-a-charge" stations. There your car would be recharged in the time it would take your family to eat, and you'd be on your way again. The charge would keep your car going for 500 to 600 miles. Charging sockets of varying capacities could be installed in your home to re-energize battery-powered phonographs, flashlights, portable fans, outboard motors, chain saws, toothbrushes, tools, shavers, even electric motorcycles.

The Secret of Those New ANTI-LEAK ANTI-



Anti-leak anti-freeze spurts from a slit that has just been punched in a radiator tank (left) at Du Pont's Marshall Laboratory. Note timer is set at zero. You could lose a gallon of anti-freeze in less than five



minutes with a gash this size in your tank. Polymer balls in coolant seal the slit in 25 seconds (right) by forming a plug in the opening. Plug will remain in place even after you drain coolant.

By RICHARD C. SICKLER

One really abused part of your car's engine-cooling system is its radiator. It's subjected to all kinds of stresses and strains caused by road shocks, engine vibration, and extremes in temperature. Furthermore, the cooling system is pressurized between 12 and 18 p.s.i. This puts additional strain on the radiator, which is made up of hundreds of separate parts held together by solder. If the solder fails the radiator will leak, you lose coolant, your car overheats—and you have trouble.

Herb Hannigan, technical manager for Union Carbide's Prestone anti-freeze says "many cooling systems begin developing minor leaks between 12,000 and 15,000 miles, and the use of an anti-leak anti-freeze gives the owner added insurance against leakage and failure."

Within the past year, breakthroughs have been announced by Du Pont, manufacturer of Zerex, and Union Carbide, which produces Prestone. Other leaders, like Dow Chemical Company, are also adding anti-leak materials to their brands.

Du Pont chemists developed a way to produce tiny plastic polymer spheres, which vary in diameter from less than 1/1,000 inch to 20/1,000 inch. The thick-

ness of this page is about 2/1,000 inch. These balls are dispersed throughout Zerex. When it is diluted by water in the cooling system, the balls remain suspended and are continuously circulated.

When a leak occurs the balls sweep to the opening. The larger balls cannot pass through and become lodged in it. The smaller balls follow, and in a few seconds the leak is completely plugged.

The hundreds of particles that make up the plug become fused into a solid mass by continued internal pressure and high temperatures. The coolant, still circulating within the system, continues to be effective. It will seal many more leaks. Even when the cooling system is drained and refilled, the plug will continue to seal leaks.

Andy Rutkiewicz, leader of the Du Pont group that developed the polymer system, says "We find that more than 90 percent of the leaks that occur in the cooling system's radiator are cracks—not holes—and most occur where the upper and lower tanks are soldered to the radiator core. Some of these cracks can be three or four inches long, and if they're less than 20/1,000 inch wide, which most are, anti-leak Zerex anti-freeze will seal them."

In contrast, Union Carbide uses inorganic fibrous matter, about one millionth

FREEZES

of an inch in diameter. These fibers are capable of forming tightly woven mats that plug the hole or crack. They are dispersed in the Prestone anti-freeze, and circulate freely through the cooling system.

When a leak occurs, the fibers are forced into the hole by pressure, and in a few seconds a plug is built. The plug is practically indestructible.

Union Carbide has tested its anti-leak anti-freeze in old and new passenger cars and trucks. Four holes 10/1,000 inch in diameter were drilled in each radiator, which had been filled with the anti-leak anti-freeze. The cars were then placed back in service. Each has been periodically checked; no failures occurred.

Du Pont has done extensive road testing of its anti-leak Zerex, using a fleet of 70 taxicabs. Constant starting and stopping in big-city traffic puts severe strain on a cooling system. As part of their tests, Du Pont removed the anti-leak Zerex from cabs that had traveled more than 15,000 miles. The used solutions were put in cabs with leaking radiators and the leaks were sealed.

The width of the hole or crack that can be sealed by either Zerex or Prestone is determined by the size of the suspended material, and this is naturally limited by the dimensions of the passages in the radiator and heater cores. Heater cores vary in widths from 35/1,000 to 45/1,000 inch. Radiator cores range between 55/1,000 inch and 70/1,000 inch. The dimensions of the polymers or fibrous particles must be less than the heater-core dimensions, or they would immediately clog up the cooling system.

These anti-leak anti-freezes will prevent most leaks, but mechanical repairs may be necessary when the hole or crack exceeds 20/1,000 inch, the size of the largest particles. And they won't plug breaks in your hoses, pump seals, and cylinder-head joints. If leaks persist, use a heavy-duty stop leak.



How new anti-leak coolant seals holes is seen in enlarged photos. Du Pont Zerex streams through crack, which is four millimeters long and 10 mils wide (top). Seconds later, flow has been almost dammed by a bridge of polymer balls (middle) in the anti-freeze. Particles then wedge against each other to form a permanent plug, closing gap completely after a few additional seconds (bottom).



Only now do explorers and workers begin to feel at home far beneath the sea—and a noted aquanaut gives you an inside view of the revolution in diving gear that is bringing it about

By CMDR.
SCOTT CARPENTER,
USN (RET.)

*World-renowned astronaut
and aquanaut*



Latest scuba gear is setting new marks. Navy divers, right, are pictured during record-breaking feat of living for three days at simulated depth of 1,000 feet, in Duke University pressure tank last December. Their Mark IX helium-oxygen gear, of semiclosed type like Mark VIII (left) but much lighter, is solely for tethered diving, carries only small emergency "come-home" tank of breathing gas.

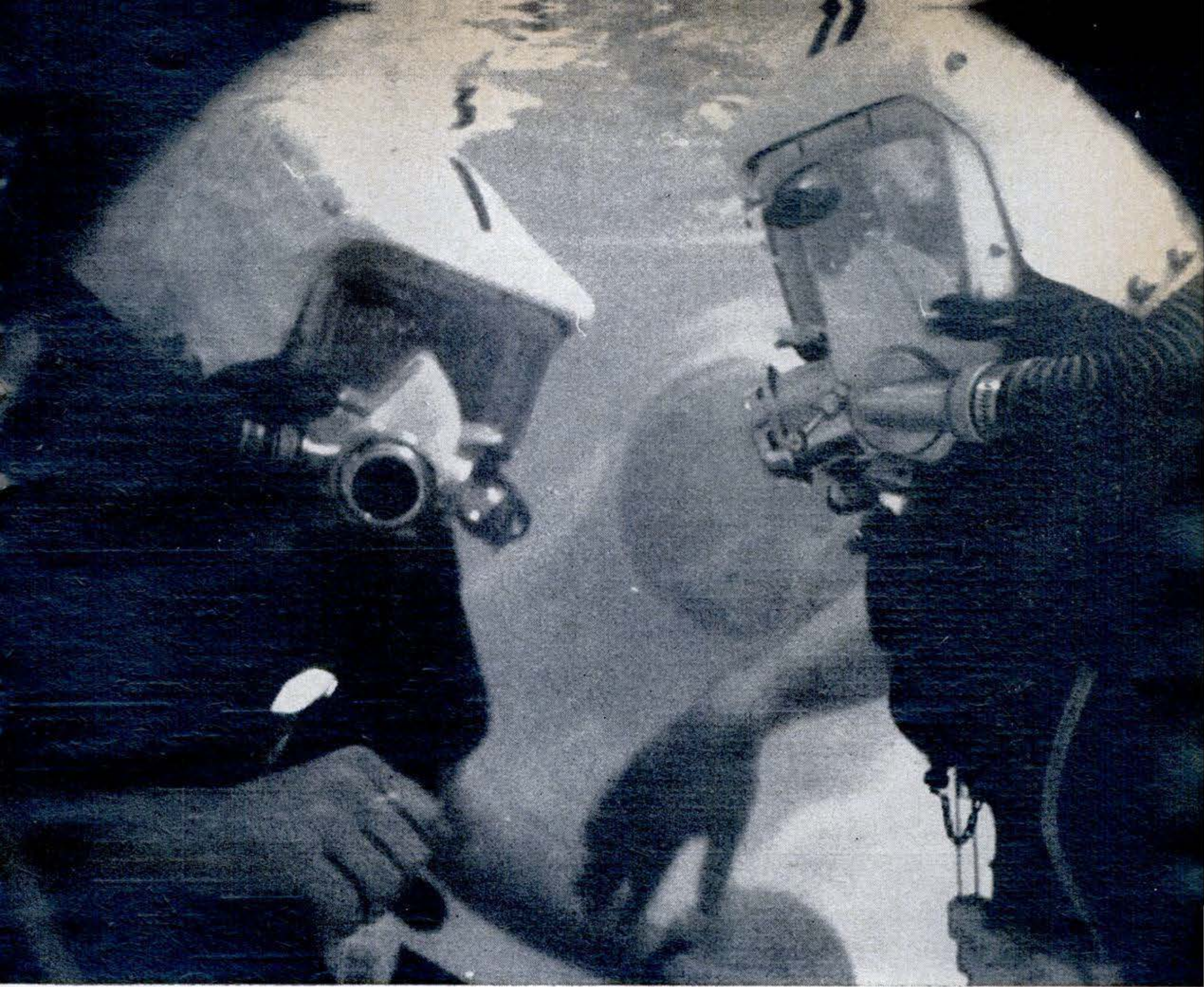
New Underwater

Navy's Mark VIII gear for aquanauts, a semi-closed-circuit design, has about everything. Hoses supply helium-oxygen breathing gas, and hot water to keep diver warm. For free swimming, he detaches umbilical and breathes gas from back tanks.

Today the poles, the highest mountaintops, and even the moon are man's domain. Next will come his conquest of the ocean depths. Self-Contained Underwater Breathing Apparatus, scuba for short, will help make it possible.

Advanced scuba gear now allows us to swim freely at depths of more than 1,000 feet, once thought forever unattainable. We can see within reach the great undersea expanse of the Continental Shelf beyond our shores. What that means to us, a Navy report puts concisely:

"The reasons for extending man's diving capabilities to greater depths are legion. The general goal is to take advantage of the vast continental shelf areas for commercial exploitation and military



Breathing Systems

defense. Among specific goals are submarine rescue, deep salvage, oceanographic research, oil and gas, mineral mining, submarine farming."

A free-swimming scuba diver carries his breathing gas in tanks on his back. Today this gas may be air, pure oxygen, or a mixture like helium and oxygen—and the choice determines the depth attainable with his diving gear.

In recent years, the beginning of diving operations from sea-bottom habitats or bases—like the Navy's Sealabs, and the Tektite project described elsewhere in this issue—has made feasible another kind of diving system. A habitat-connected hose, often called a "hookah," supplies a diver's breathing gas through a hose

from his nearby underwater base, giving the advantage of practically unlimited endurance. Strictly speaking, this is not a scuba system—not being self-contained—but it uses scuba gear.

Peril on a hookah hose. Sealab II, 205 feet deep off La Jolla, Calif., used hookah equipment extensively for close-in underwater activity. But the hoses were an unwelcome encumbrance, and there was danger from a kinked hose—as I learned during one of my Sealab II dives.

All of a sudden, my supply of breathing gas was cut off—as if the pumps had failed, which I thought was the case.

What do you do when you're 200 feet down, with nothing to breathe? I managed a breath-holding swim back to the

Sealab's entrance hatch. As I entered, I called to the diving supervisor to send someone out to help my "buddy" diver, Bill Coffman, thinking he would be in trouble, too. But within seconds he popped up beside me in the hatch. He had seen my hasty retreat and, like a good buddy, had followed me home to make sure everything was all right.

What had happened, we found, was that my hose had kinked—and after removing the kink, we finished our dive.

Subsequently the Navy has developed hookah-type diving gear that includes at least a small emergency "come-home" tank of breathing gas on the diver's back.

Today—many kinds of scuba gear. Self-contained scuba equipment is presently available in four major types:

- Open circuit.
- Semiclosed circuit.
- Closed circuit.
- Closed circuit, oxygen rebreather.

What distinguishes open, semiclosed, and closed circuits is whether all, some, or none of the diver's exhaled breath is exhausted to the sea.

The simple open-circuit gear is the one that most people associate with diving. The first open-circuit scuba was designed and used during World War II by Jacques-Yves Cousteau and Emile Gagnan, who called it the aqualung. Its key element was a simple valve that automatically delivered air to a diver, from compressed-air tanks on his back, at the proper pressure regardless of depth.

It was this equipment that introduced me to the fantastic sights of the underwater world, and helped point my way to a career in oceanography. Far the most readily available type to the sport diver, it is the great breakthrough that has sparked the present tremendous interest in underwater recreation.

Refinements incorporated in its design have included check valves in the hoses to prevent flooding; and a reserve valve that warns a diver when to start for the surface by making inhalation difficult while there is still a reserve of air in the tanks. Repositioning this valve manually makes breathing easy again during the ascent.

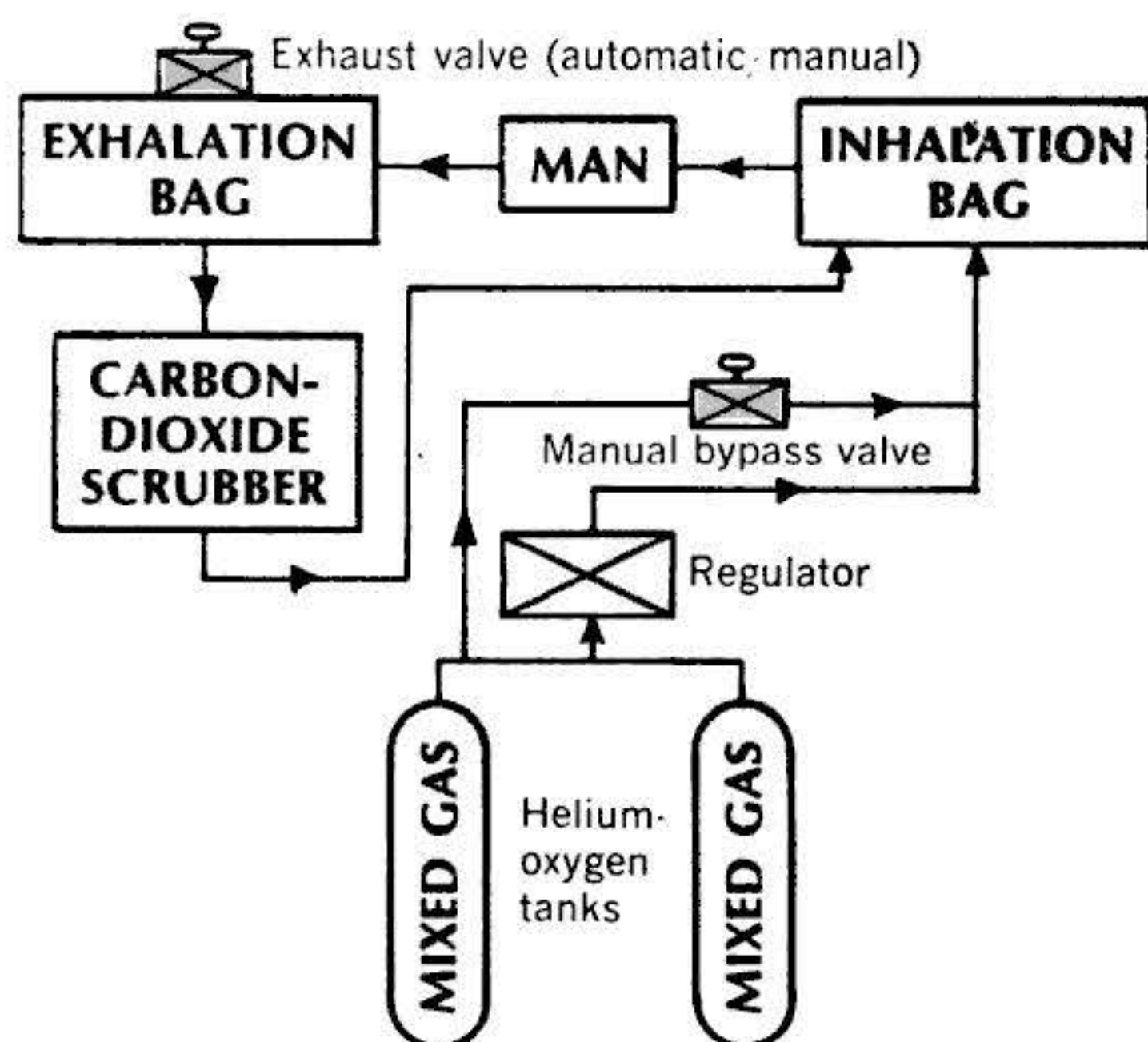
A minor departure from the original design is the single-hose regulator, incorporating both a second-stage inhalation

Four kinds of scuba gear—and a promising variation on the way

How major types of scuba equipment work is shown in schematic diagrams, adapted from author's sketches. Presently available are first four kinds. A coming new cryogenic form of closed-circuit gear will offer advanced innovations, including a heating device to combat bitter cold of the deep sea.

Depths attainable with various kinds of gear depend on the breathing gas they use. Pure oxygen, in attractively compact and lightweight "closed-circuit, oxygen-rebreather" type, sets shallowest limit of about 35 feet. Air-breathing diver, with "open-circuit" gear like the pioneer aqualung, can descend as far as 200 feet. Greater depth calls for helium-oxygen breathing mixture used in types of gear shown by the three diagrams in lower row.

SEMICLOSED-CIRCUIT SCUBA, MIXED GAS

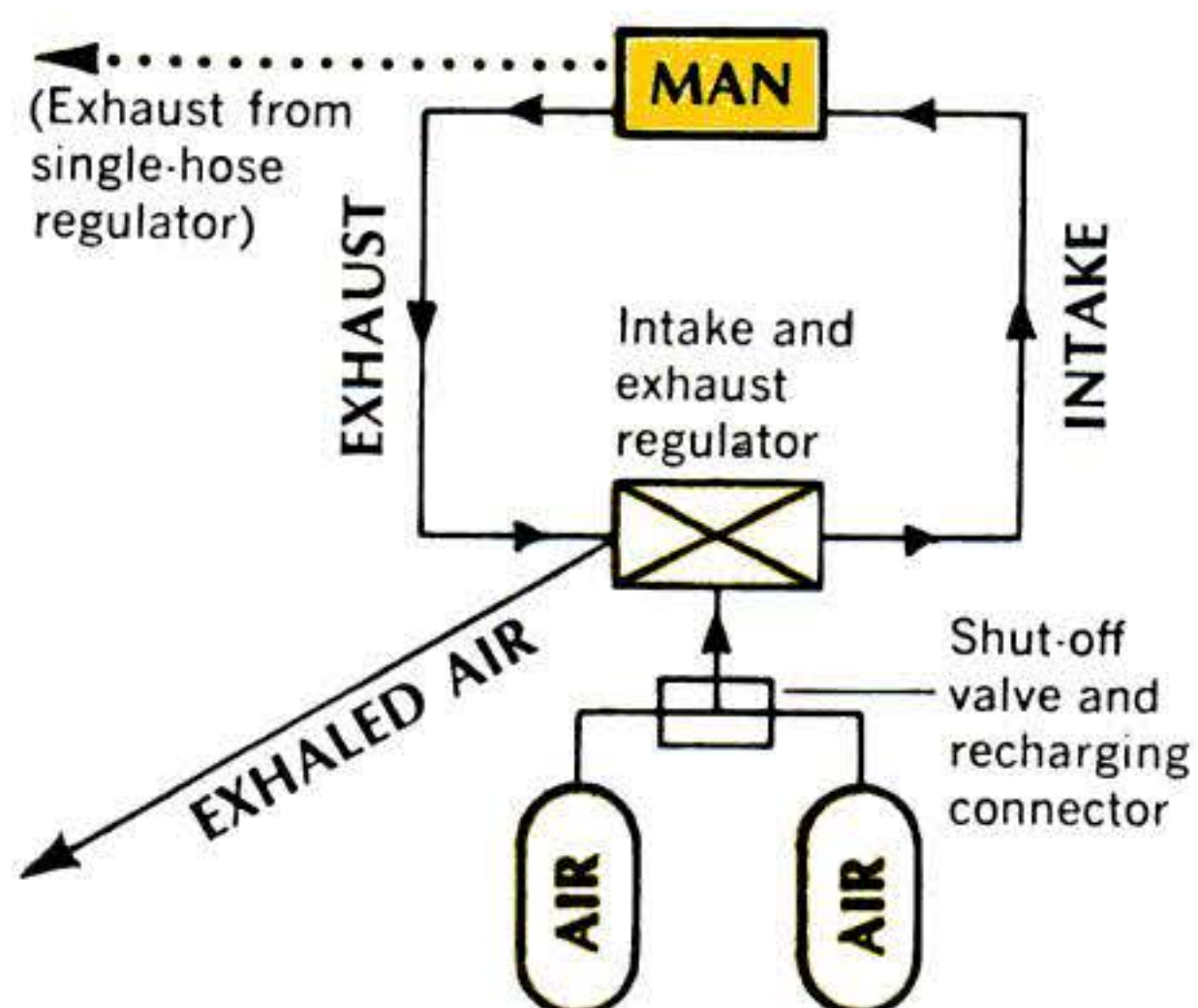


regulator and the exhaust-pressure regulator in the diver's mouthpiece. Two large hoses lead to the mouthpiece of one type, and only one small hose to the mouthpiece of the other, clearly distinguishing them.

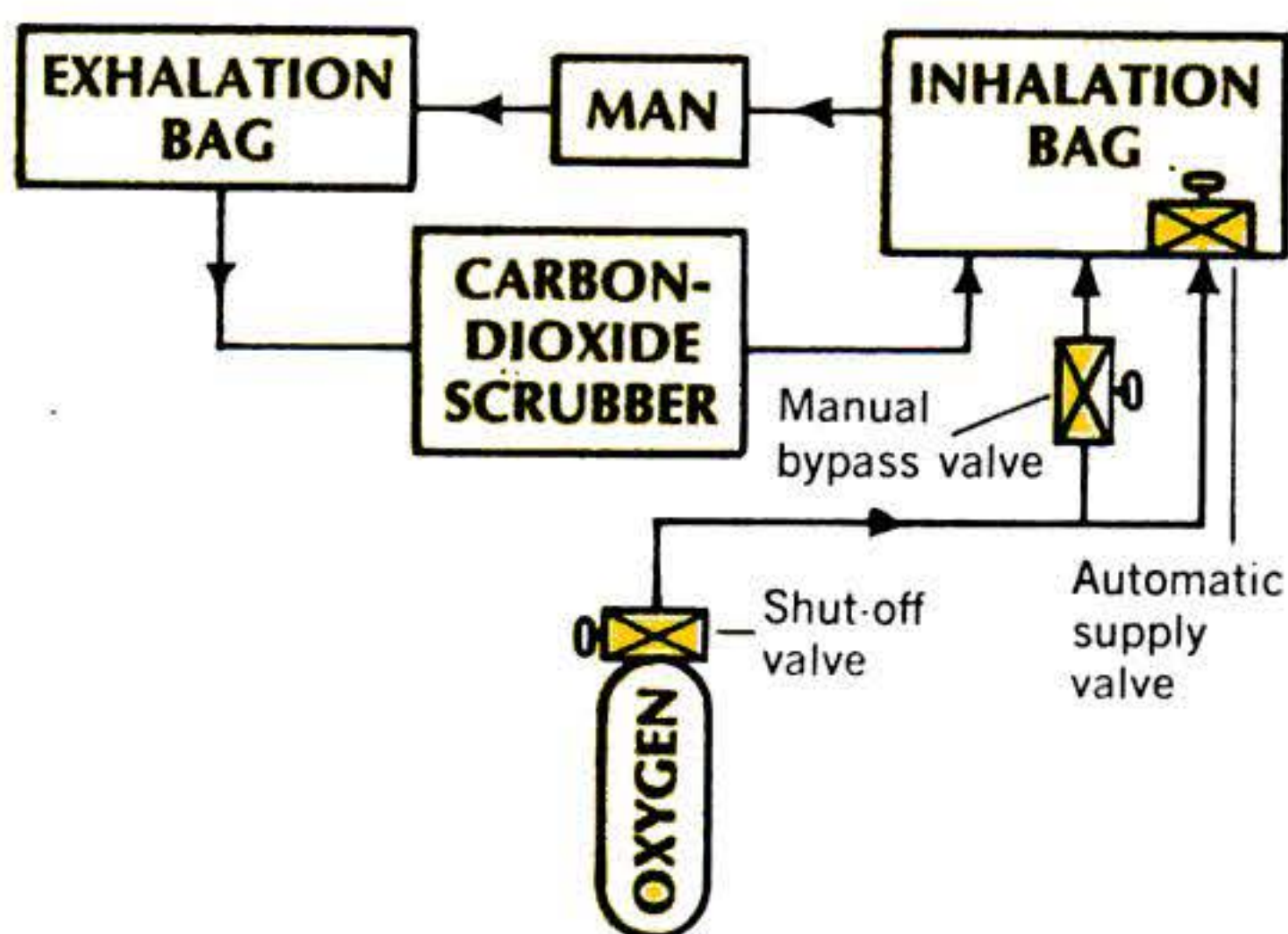
Another variation is the open-circuit cryogenic gear, using liquid air. Because more air can be carried in liquefied than in compressed gaseous form, this gear has the advantage of longer endurance. A heat exchanger and pressure regulator serve to raise the very low liquid-air temperature to that of surrounding seawater.

Beyond 200-foot depth, open-circuit diving gear becomes less practical, because rising pressure greatly increases the rate of air consumption. Use of air also

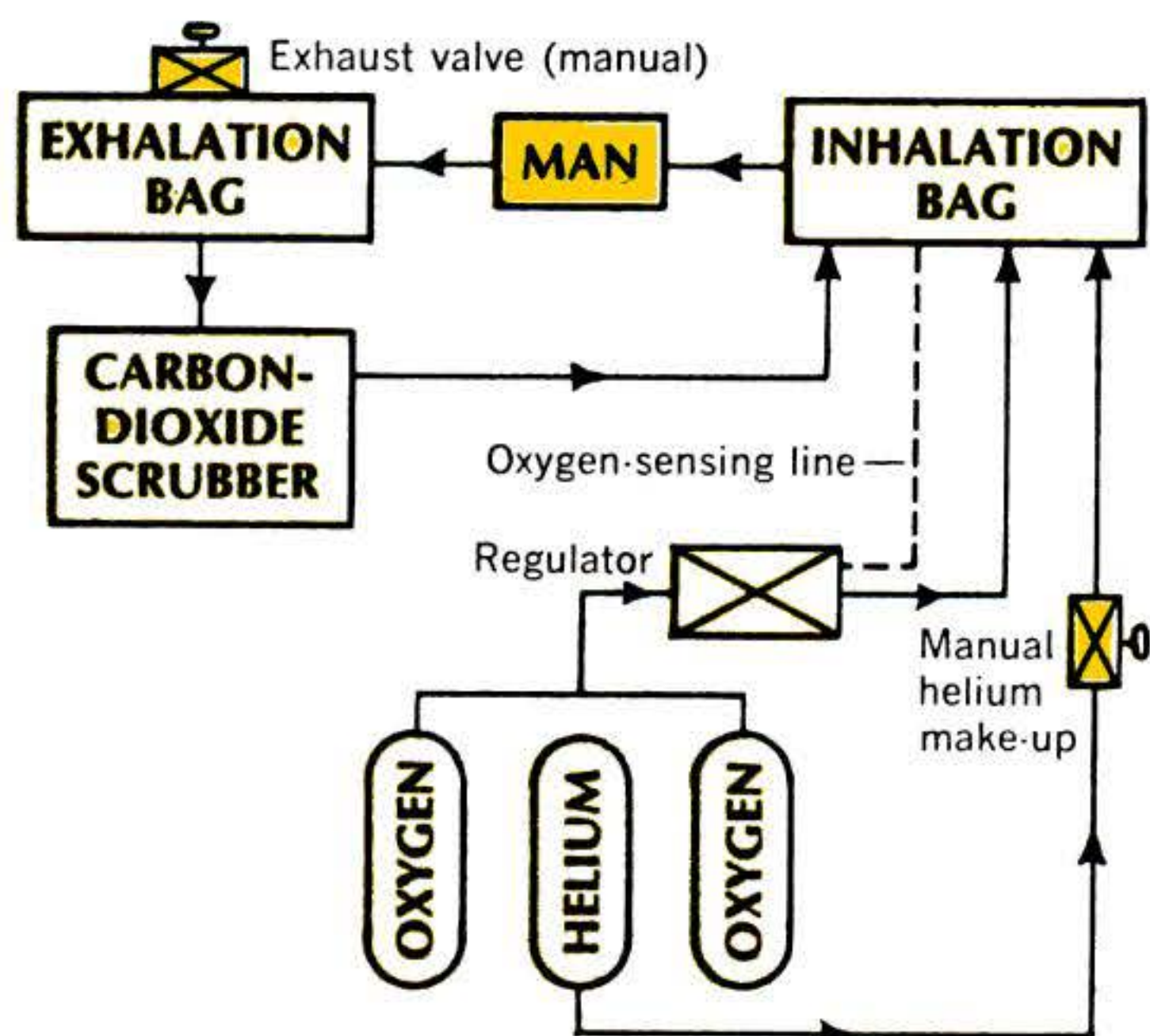
OPEN-CIRCUIT SCUBA with double-hose regulator



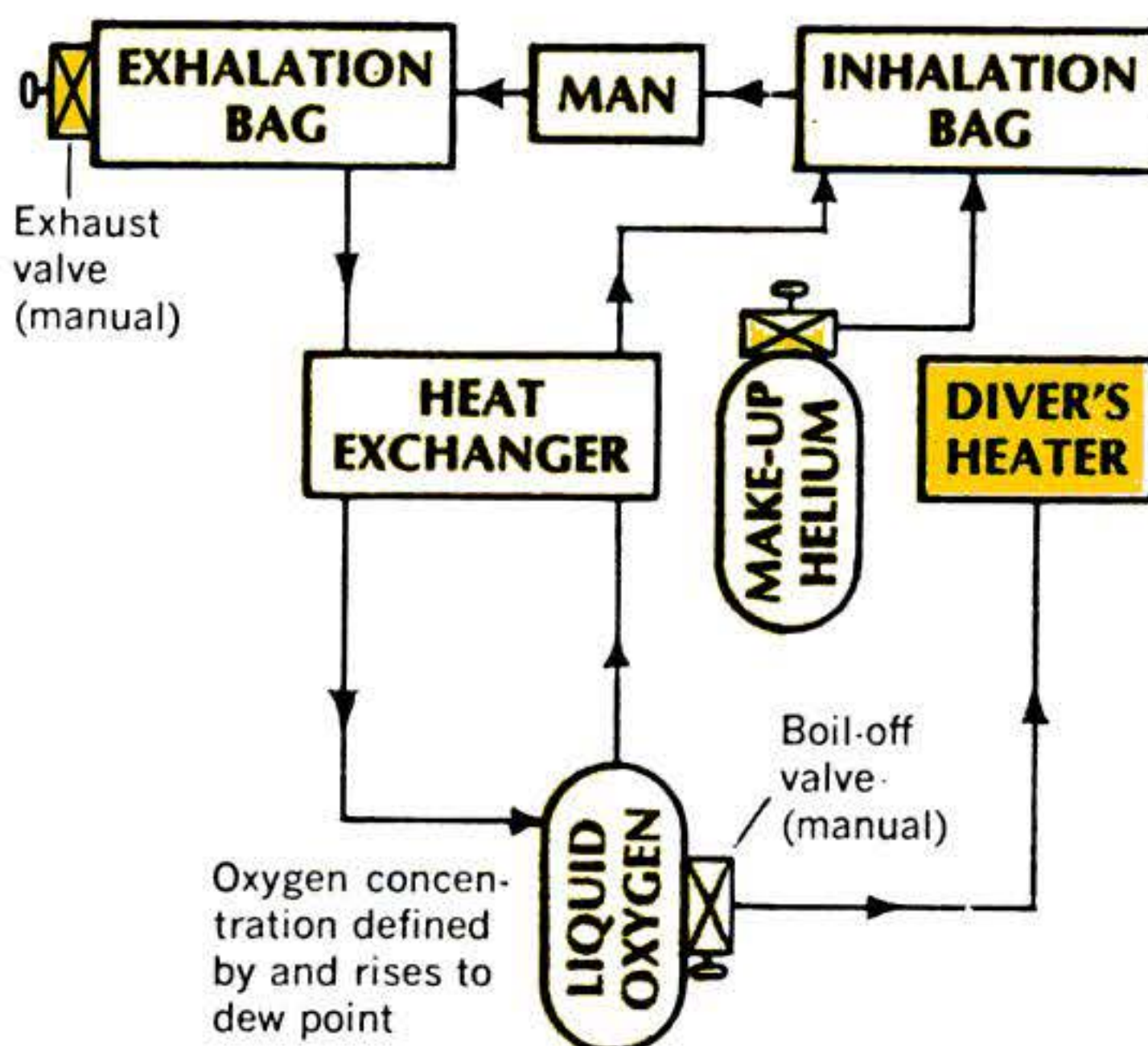
CLOSED-CIRCUIT SCUBA, OXYGEN REBREATHING



CLOSED-CIRCUIT SCUBA, MIXED GAS: electronic type



CLOSED-CIRCUIT SCUBA, MIXED GAS: cryogenic type



becomes more dangerous because of the "rapture of the depths"—narcosis caused by breathing high-pressure nitrogen, which constitutes about four-fifths of air.

At modest depths, for short periods, nitrogen narcosis can be tolerated by a good diver. As diving depth and duration increase, so does the danger. Effects vary from man to man and from day to day, but nitrogen narcosis is deadly to anyone at 400 feet. Even at shallower depths it has killed many good men.

Oxygen rebreathing gear. Probably the most compact and lightweight of currently available diving gear is the closed-circuit, oxygen rebreather type, and it has the advantage of long endurance. However, it has the shallowest depth limit.

Breathing pure oxygen avoids nitrogen narcosis, but raises another problem—oxygen toxicity. Prolonged breathing of pure oxygen at a pressure greater than that of about 35 feet of seawater will cause convulsions, followed shortly by death.

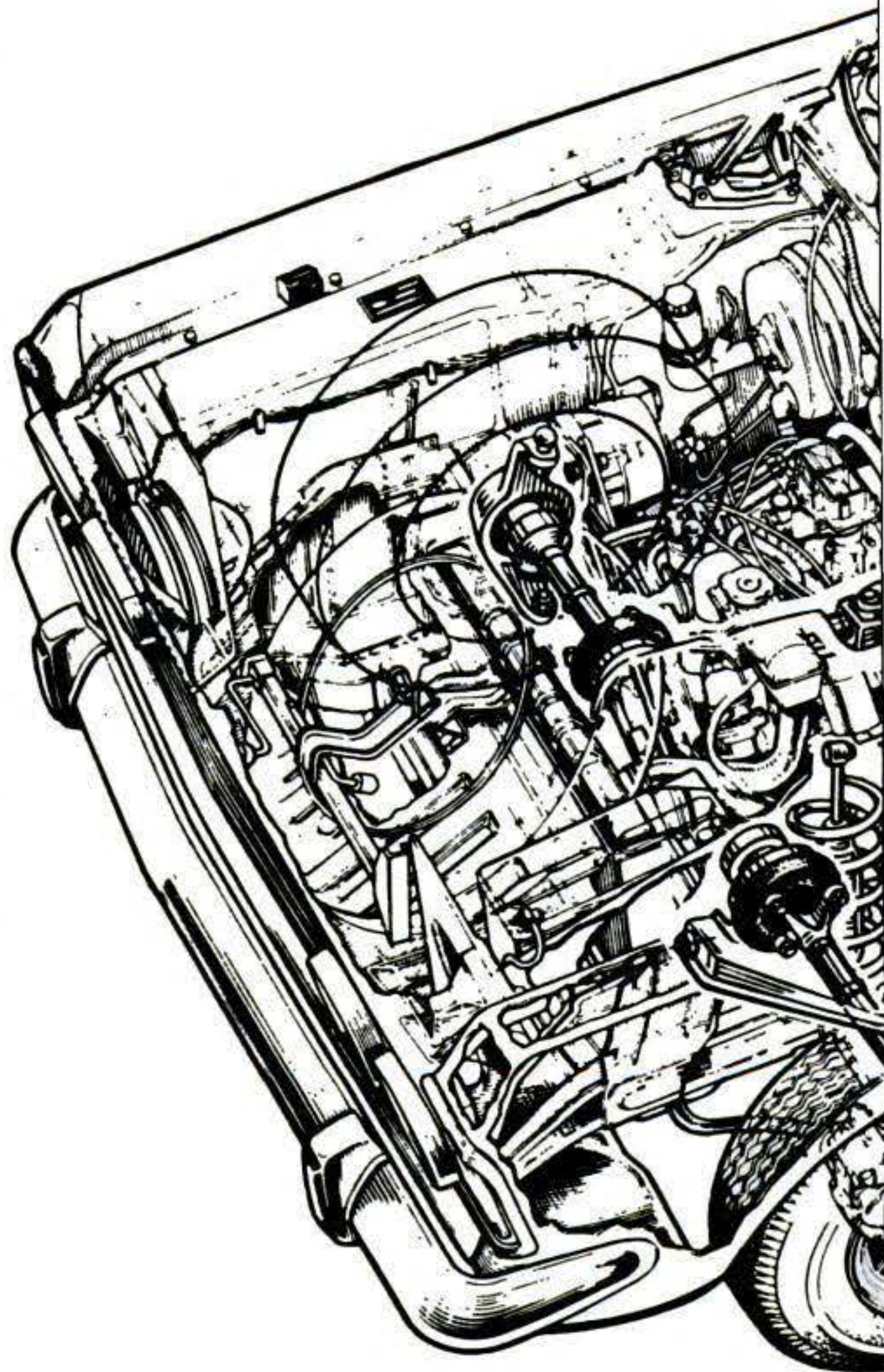
Clearly we need to dilute oxygen with some gas that is neither narcotic nor otherwise toxic under pressure. The answer is helium gas. The scuba gear that permits swimming at depths exceeding 1,000 feet uses a helium-oxygen mixture.

Before this next generation of underwater breathing devices became practical, however, another problem had to be solved. To avoid oxygen toxicity, the proportion of oxygen to be mixed with

[Continued on page 198]



Innocent-looking, this four-wheel-drive Zephyr can't be told apart from other police cars. The author, David Scott, at the wheel, finds no unusual controls or instruments, other than police equipment. But in the cutaway drawing you can see all the special hardware that has made this police car the safest car in the world.



New Police Car Has

Wet-weather emergency situations can't faze this combo—it's unbeatable for safety

By DAVID SCOTT / *PS* European Editor

Ever try to drive an ordinary car around a sharp curve on a wet or snowy day, then suddenly slam on the brakes in the middle of the turn? You'll certainly go into an uncontrollable skid.

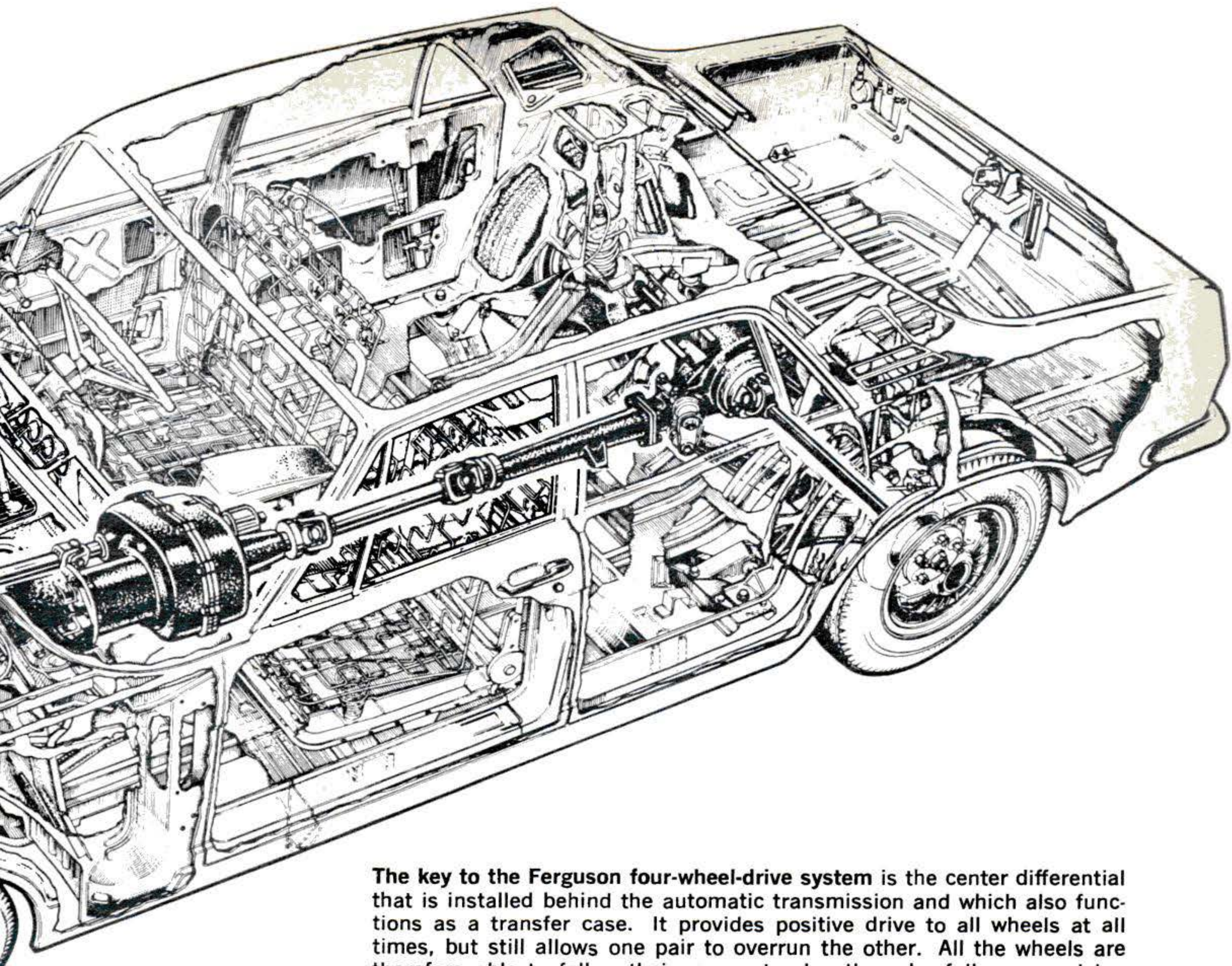
But when I tried this foolhardy maneuver with a special police car, it just slowed down and stopped, in perfect balance. What made this unlikely feat possible? Two special systems: the Ferguson all-wheel drive, which eliminates wheelspin,

and the Maxaret brake system, which banishes lockup and skidding.

The car was a Ferguson-converted Ford Zephyr—one of 18 that British government authorities have turned over to police forces for evaluation in patrol service. Perhaps the safest car in the world, it may one day prod the auto industry into mass-producing an all-weather traction system that you can buy as a regular option for \$500 or less.

Man at the wheel. When I drove the car, the police also brought me an older rear-wheel-drive Wolseley for comparison. From a standing start on a wet lawn, the Wolseley was left at the post, gouging ruts; the Zephyr shot ahead without fuss.

Around a simulated traffic circle, on



The key to the Ferguson four-wheel-drive system is the center differential that is installed behind the automatic transmission and which also functions as a transfer case. It provides positive drive to all wheels at all times, but still allows one pair to overrun the other. All the wheels are therefore able to follow their own natural path under full power, giving superb grip on starts and turns even on a slippery surface. Under braking, it is impossible for a single wheel or a pair of wheels to lock up—all slow down at precisely the same rate.

Power and Antiskid on All Four Wheels

wet grass, the Wolseley spun out and came to rest stern-ahead. The Zephyr hewed to its merry way, round and round. Still circling fast, I hit the brakes, hard. The car slowed sharply, not deviating a hair from its middle-of-the-road path. It was incredible!

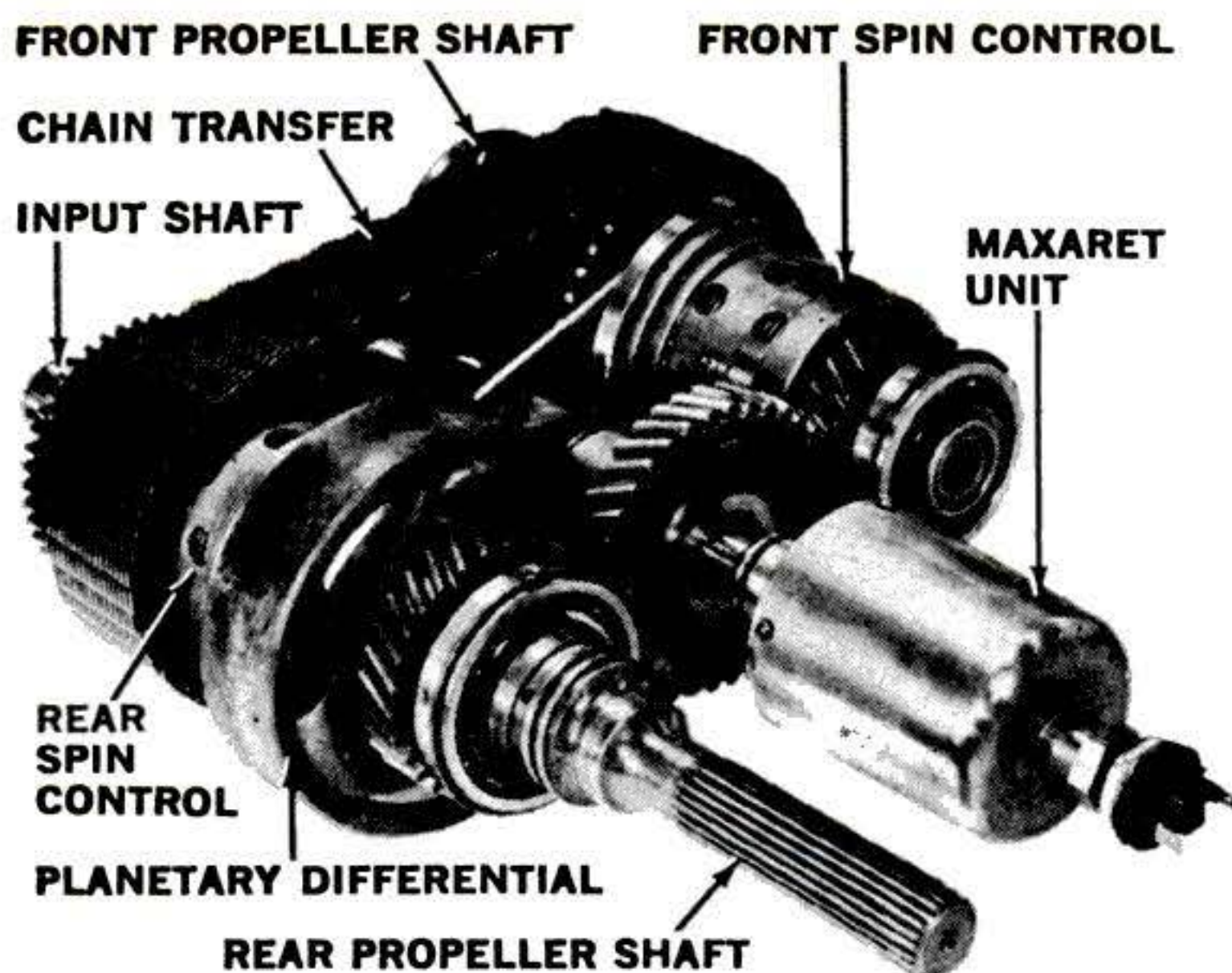
Then I took the Zephyr out on a rain-soaked country road. Getaway at full throttle from a standing start was flawless—not a trace of wheelspin or slewing. I hurtled into a sharp bend at 45 m.p.h. and pounded the brake pedal at the apex of the curve. It was an idiot's panic stop, but

the Zephyr pulled up dead in its tracks.

A real killer. That was my final test: a crash stop with two wheels on the hard road, and two wheels on loose gravel along the shoulder. Once again, the car stopped squarely on all four, even with hands off the steering wheel!

The Ferguson system is a significant British breakthrough in road traction. Conventional four-wheel drives with both axles geared together are fine on snow or mud, where a little tire-spin doesn't matter so long as the wheels keep turning.

But what happens if you drive such a



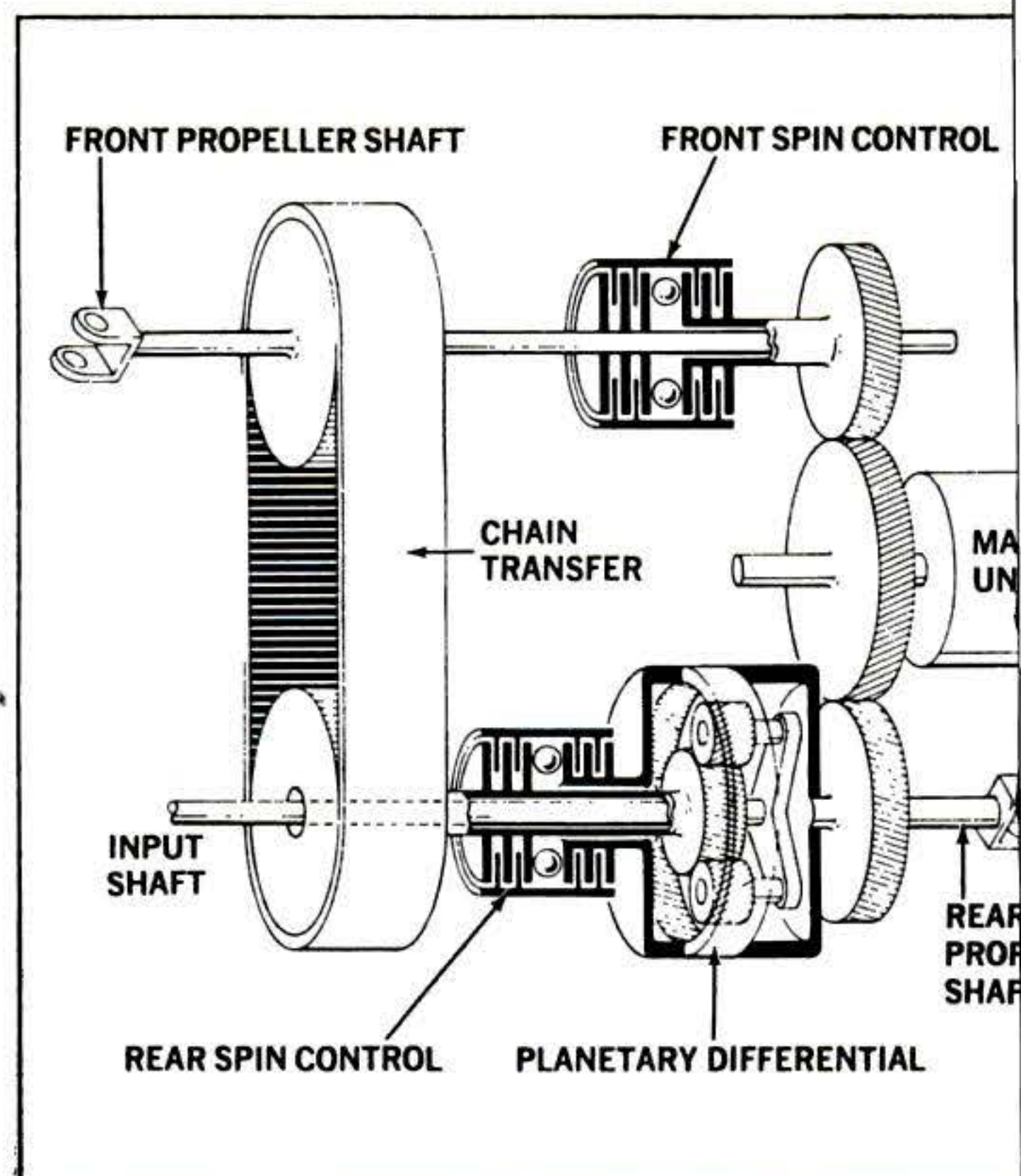
Planetary center differential is driven through the planet carrier. Output to the rear wheels is taken from the annulus, and the sun wheel drives the offset shaft to the front wheels via a chain. Spin-control units are fitted on both front and rear output shafts to check rotational speed.

vehicle without disengaging the front axle? You get serious tire scrub with attendant loss of grip. That's because the front wheels roll in wider arcs on turns than the rear ones, so must rotate faster to cover the longer distance in the same time. Since they're locked together, one must slip. If you put a third differential between the two axles you lose the advantages of four-wheel drive, for then one pair of wheels is free to spin on a slick patch.

Harry Ferguson Research, of Coventry, England, licks these snags with a central differential of unique design (see schematic drawing). Gear ratios are selected for a 1.7:1 torque split between the two axles, so the rear gets 63 percent of the torque and the front 37 percent. This limits the understeer tendencies of a front-drive car.

Then comes the crafty bit. The front wheels can overrun the rear ones by 20 percent, but no more. To achieve this, the front output shaft is geared to the rear shaft through a twin-section multiplate clutch that is normally disengaged, with its two portions separated by ball ramps. This is the spin-control unit.

Here the gear ratios are such that the section coupled to the rear shaft normally runs 20 percent faster than the one on the front shaft. Thus, the instant the front wheels start to spin, their clutch-pack catches up with the rear one. This forces the steel balls up their ramps to compress



and engage both clutches with a wedging action, thereby locking front and rear axles together. When the front wheels are rolling again, the clutches disengage.

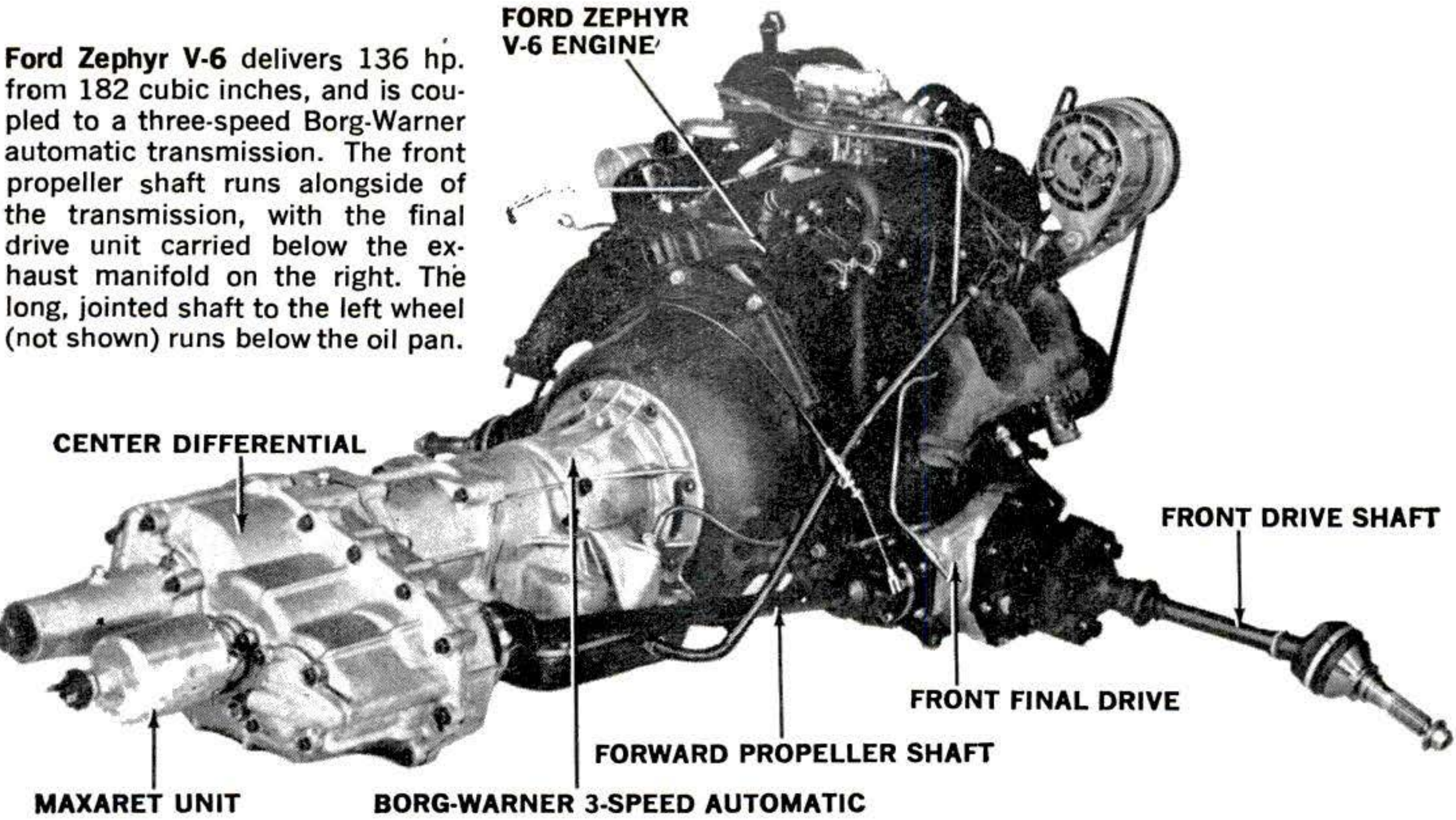
There's a similar spin-control unit for the rear axle, this one allowing a five-percent overrun. It is also coupled between the front and rear shafts, but in this case one of the clutch-packs is connected directly to the rear shaft.

Antiskid brakes complement the built-in safety of the remarkable drive train.

The Maxaret. This speed-sensing unit with a flywheel geared to the input side of the third differential is the heart of the system. The flywheel is axially loaded by a calibrated spring against a cam mechanism and friction clutch on its shaft that spins it at a speed proportional to that of the road wheels.

When either front or rear wheels slow down excessively under hard braking, the flywheel "runs on" relative to its shaft, causing the cam to impart an axial thrust. This movement closes an electric switch operating a solenoid air valve that reverses the action of the vacuum brake servo. Thus hydraulic pressure to individual brake cylinders is reduced to prevent locking of the wheels and, at the same time, the pedal is kicked upward against your foot. As the brakes are eased off and normal road-wheel rotation is restored, the spring-loaded flywheel returns to its cam and opens the switch.

Ford Zephyr V-6 delivers 136 hp. from 182 cubic inches, and is coupled to a three-speed Borg-Warner automatic transmission. The front propeller shaft runs alongside of the transmission, with the final drive unit carried below the exhaust manifold on the right. The long, jointed shaft to the left wheel (not shown) runs below the oil pan.



Now you can push the pedal again, and the pulsating antilock cycle repeats until the car comes smartly to rest. Throughout this period, you get complete directional stability and steering control even when braking on a turn. Moreover, the system permits much-higher safe pedal pressures, and hence shorter stopping distances. The pulsations give early warning of treacherous road conditions, and keep you from coming to grief on them.

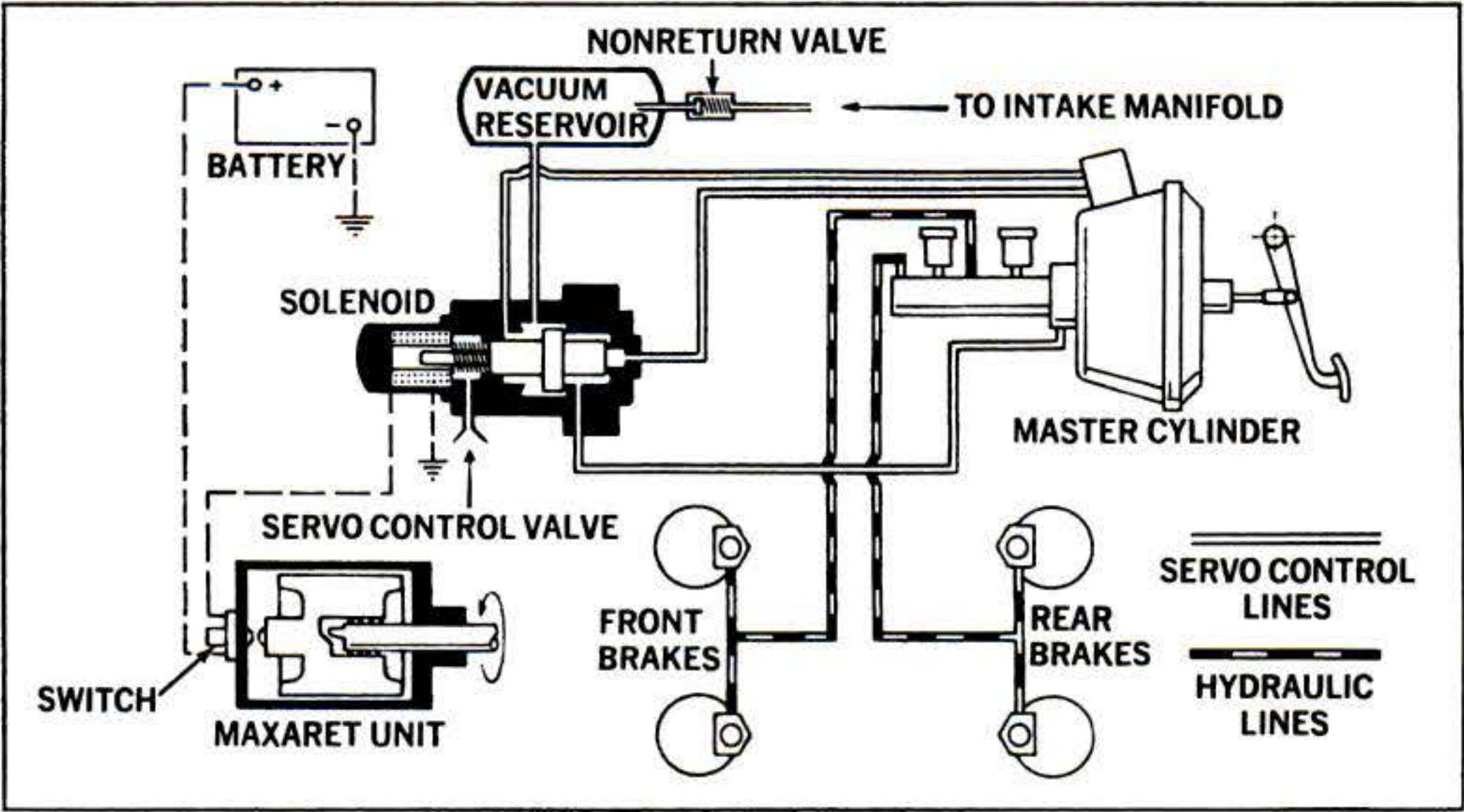
The Zephyr conversion. This involved replacing the engine and oil pan with a cast-aluminum sump that houses the front differential in a bulge along one side. The central differential bolts to the rear of the transmission, and drives the front and rear axles through open propeller shafts. To accommodate this additional machinery,

the engine is slightly raised and offset.

The MacPherson spring-leg suspension in front is replaced by Mustang-type assemblies with coil springs above the upper control arms. This exposes the wheelhubs for the front drive shafts. Larger 10-inch disk brakes are fitted in front, but the independent rear-suspension layout, also with disk brakes, is unchanged.

You may remember that the New York State-Republic Aviation safety-car proposal of 1966 included Ferguson four-wheel drive. If the federal safety campaign continues to gather momentum, this system could become the basis for future performance standards. Ferguson says it can be built for \$500 per unit, and considerably less in really high volume. What about it, Detroit? PS

Anti-lock brakes by Dunlop Maxaret were developed for aircraft. A speed-sensing unit with a small flywheel is geared to the input-side of the center differential. Excessive deceleration in either the front or the rear wheels is signaled to a solenoid that reverses the action of the power assist. When normal wheel rotation is restored, the cycle is repeated, until you stop braking or the car comes to a standstill. This gives straight and short stops even on slippery roads.



Tips from an expert on How You Can

in the Popular Science Anti-Car-Theft Device

By ERNEST A. ZADIG

Holder of numerous automotive, electrical, mechanical, optical, and radio patents sold to Bendix, Borg-Warner, RCA, General Mills, and others. He is also author of "The Inventor's Handbook."

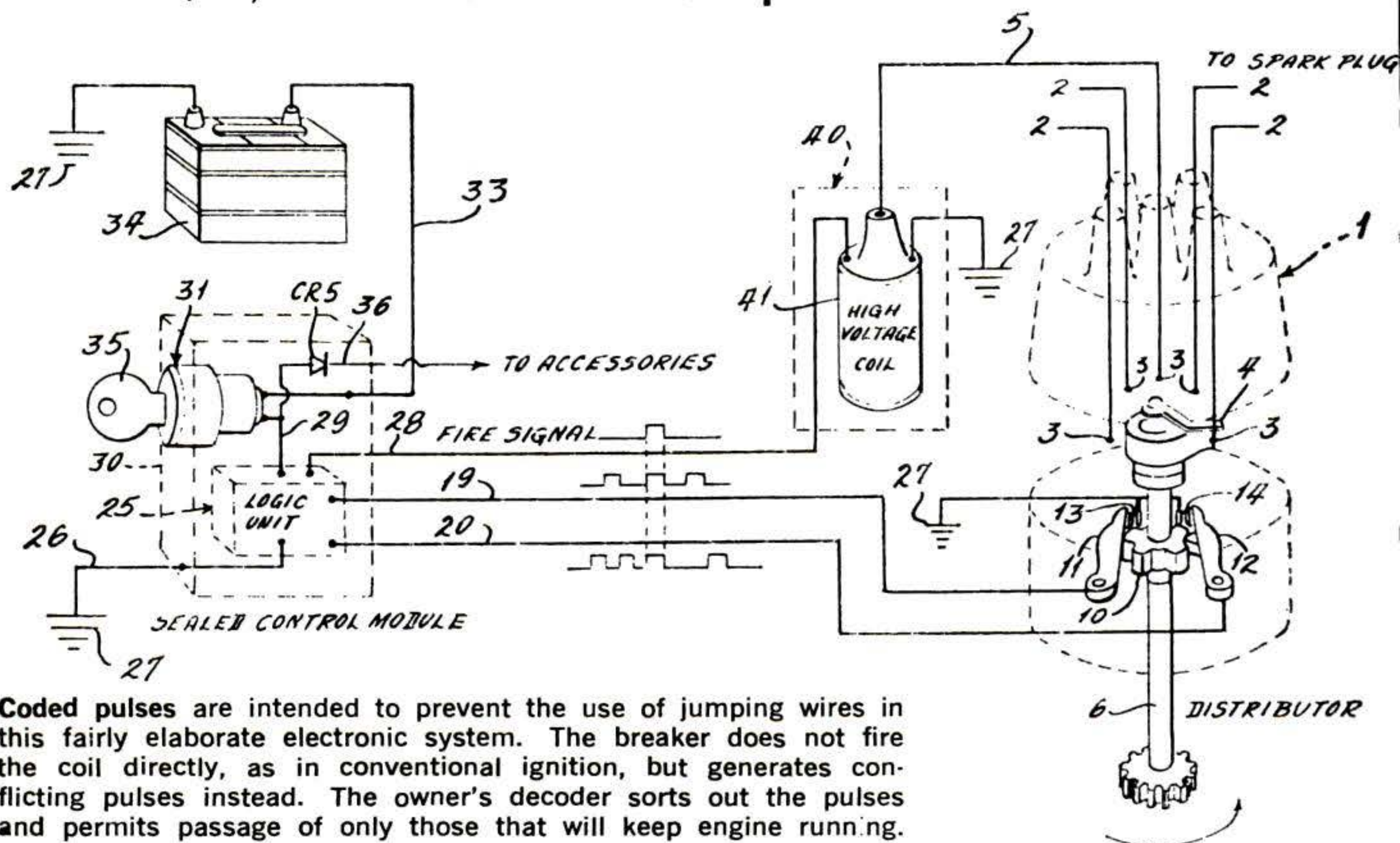
Are you dreaming up a keyless lock to capture the \$20,000 first prize in the Popular Science Anti-Car-Theft Device Competition? Then some patents I picked out in a recent search through the Patent Office files will help you shoot for that big prize or the 13 cash prizes that follow it to increase your chance of winning.

Most inventors seem to have gone to the combination lock in their desire to eliminate keys. Some have taken the

standard safe combo dial and installed it on the instrument panel for the driver to twirl before he could get going.

We have been stressing the need for practicality—and such a scheme certainly is not practical. Imagine yourself on a dark rainy night trying to align little numbers with an index mark before you can get the horses under the hood to come to life. Some inventors apparently have attempted to simplify the driver's job by supplying three smaller dials or disks, each carrying numerals from 0 to 9. When a predetermined three-digit number is set up, the lock opens. A possible drawback is that turning from 000 to 999 in sequence uncovers the secret number;

Got an idea for a gadget to prevent car thefts? Build it and win \$20,000 in this unusual competition



Coded pulses are intended to prevent the use of jumping wires in this fairly elaborate electronic system. The breaker does not fire the coil directly, as in conventional ignition, but generates conflicting pulses instead. The owner's decoder sorts out the pulses and permits passage of only those that will keep engine running.

Build a Winning Gadget

Competition sponsored by Allstate Insurance Co.

thieves, however, will want to subject themselves to so much exposure while they fool around.

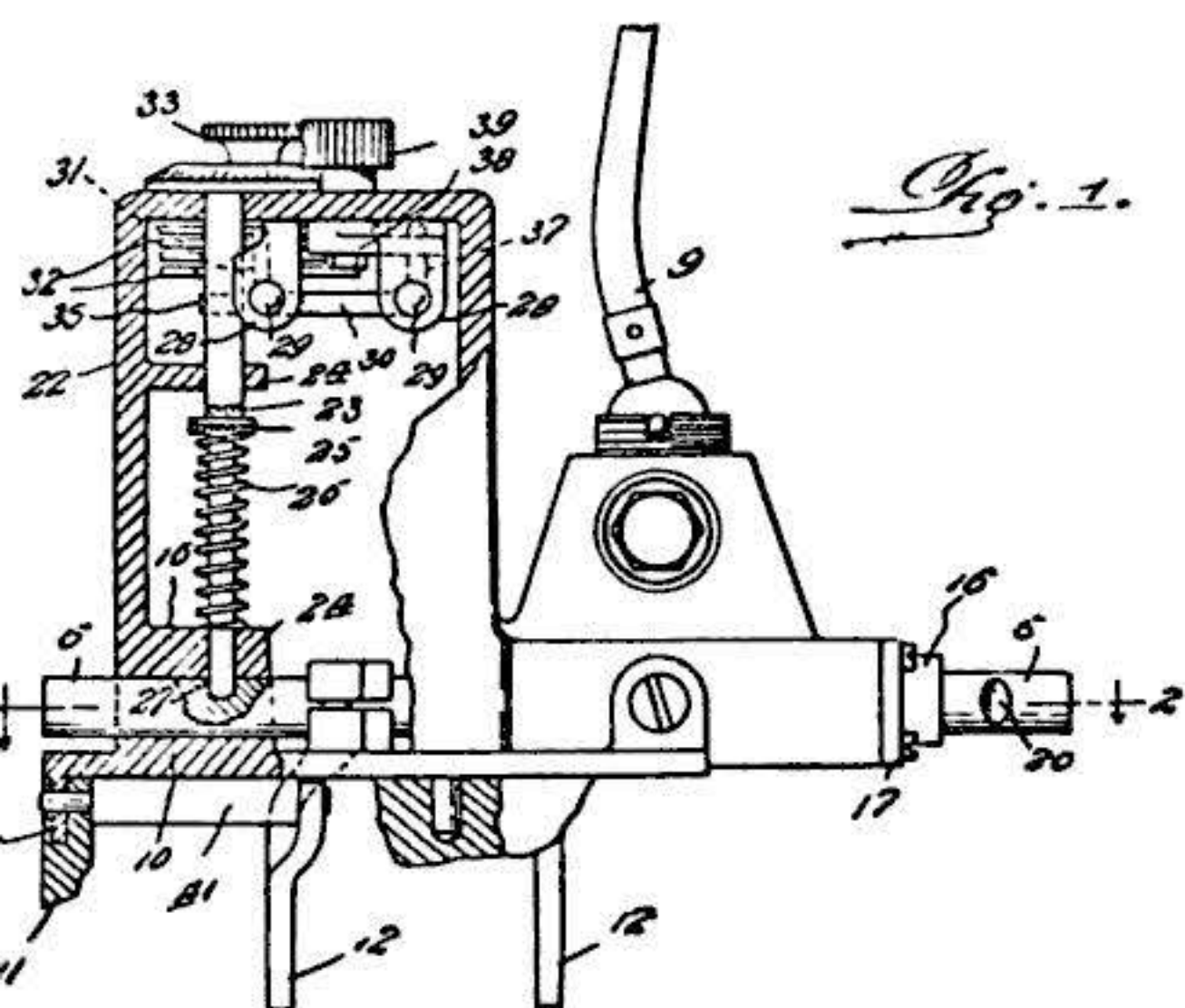
Keyless lock a possibility. Can a practical keyless lock be made? I am certain it can. One approach might be a single button that must be manipulated with a certain series of pushes and intervals. The properly spaced intervals would be the telltale that either opens the lock or sounds the alarm. Without these intervals, of course, anyone could just keep pushing the button until the car started. Such a button would not have to be especially visible, and could be operated at night.

Combo locks are not the only method

of eliminating the key. Ultrasonic means have been suggested, similar to the manner in which some TV sets are remotely tuned. Magnetism might be used. But such devices could make it difficult to provide the thousands of different combinations needed to keep Smith's gadget from starting Jones' car.

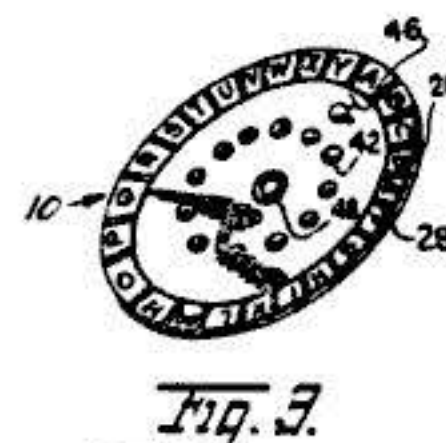
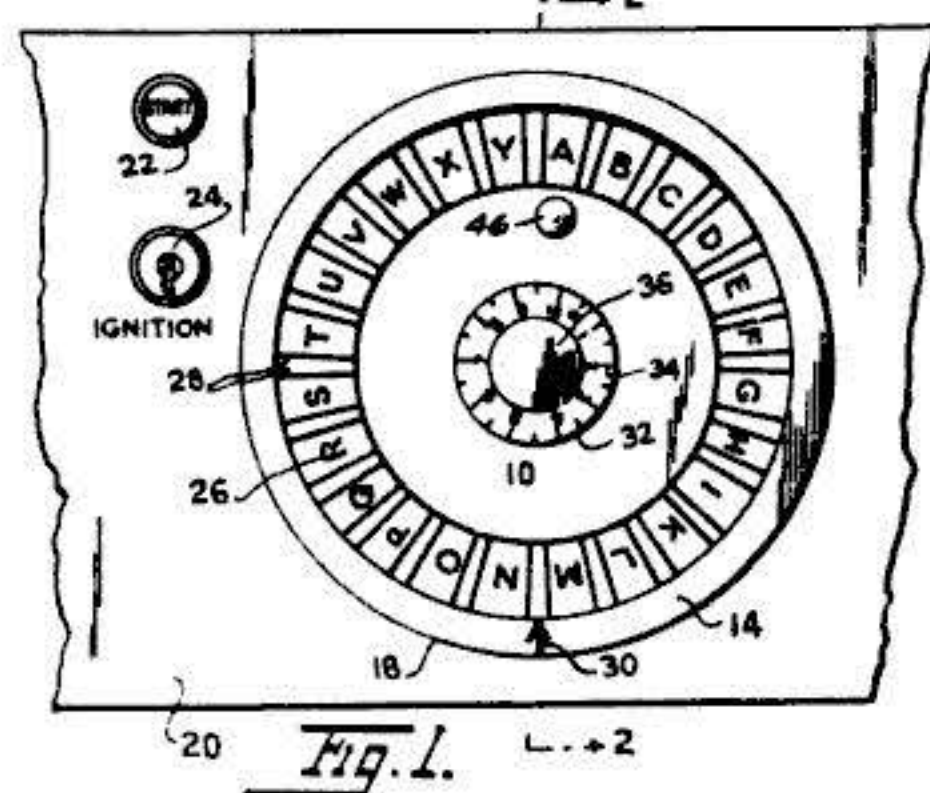
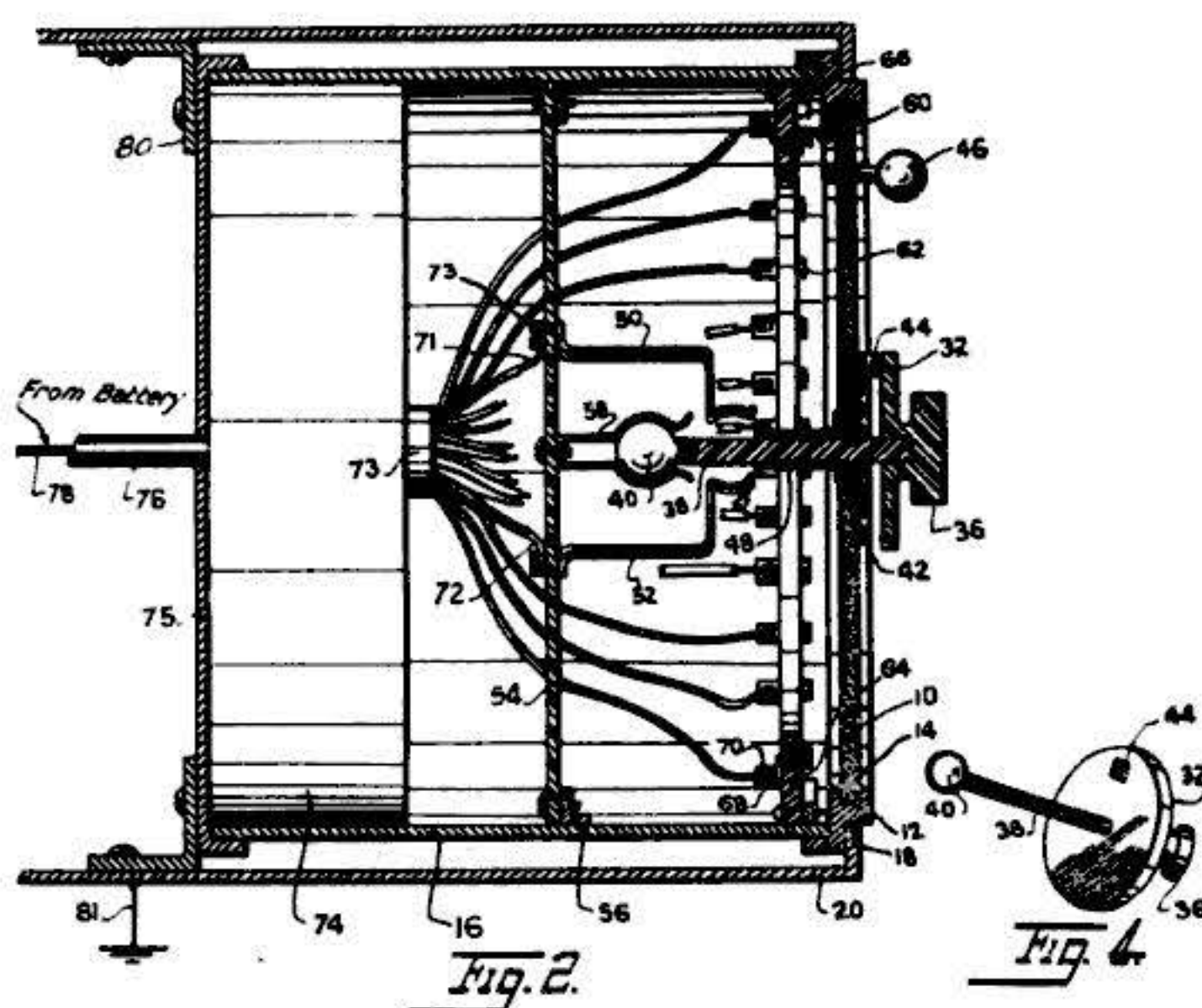
Don't let this examination of locks distract you from a possible weak point in all locking systems—even those with the theoretically perfect lock. Can the lock be bypassed by a thief in the space of time he usually allows himself for a "job"? And what about the recurring problem of the parking lot whose attendants must move the car back and forth?

Continued



have to twirl the correct numbers into the dial of this keyless transmission lock designed to guard against the oldtime "four on the floor." In the locked position both forward and reverse are in gear. Car can't move both ways at once, so remains immovable and secure. Today's locks secure the shift lever itself.

There's another approach to the use of dials in place of keys. This one works on the starter. A series of numbers must close in proper sequence before the car engine can be turned over. Dial a wrong number and the system resets itself to the beginning. Hopefully this frustrates and discourages a would-be thief.



Engines need air, fuel, ignition. Can you figure it out?

The only solution would be to leave a car so equipped in an open condition without divulging any lock secret.

Some inventions take on a sadistic character. Unauthorized operation of a car causes a tire to blow or some equally dire thing to happen. But gimmicks like that could become boomerangs; it is best to stay away from them. Anyway, such devices hold no commercial promise.

Engine cut-off? The patents I have searched show much emphasis on locks of every conceivable type. Despite this, cars still are being stolen at the rate of more than 750,000 a year. Logic therefore would seem to indicate that your efforts toward the prize goal should take another direction. The main sources of supply an automobile engine needs in order to come alive are air, fuel, and ignition; Choking off any of these would kill the engine dead, but one supply could be easier to stop than another.

As a target for your inventive skill in going after the prizes, I would place ignition at the bottom of the totem pole. The electrical system is just too darned easy to circumvent. Some crooks don't even bother to check out the ignition so

that they can jump the wires effectively. They carry a "hot box," which contains a small six-volt hot-shot dry battery and an oldtime Ford vibrator coil. Three leads dangle from it: one high-tension and two with clips.

The thief rips the existing wires from the ignition system. One clip from the hot box goes to ground, the other to appropriate contacts in the ignition system. A screwdriver shorts the starter switch and in about 45 seconds the engine is purring contentedly despite all the fancy locked switches.

Check the contest rules. The Competition rules are detailed and explicit. Yet we are getting many entries that ignore them completely.

Entries are being sent to Allstate offices and to the editorial office of PS instead of to the designated P.O. Box 772 Murray Hill, N.J. 07974. Return postage often is omitted.

Some Lazy Joes simply scribble an idea on the entry form and send it in with optimistic expectations. Under the rules of the Competition, only one thing can happen to these, and you can guess what that is.

.....

1st Prize...\$20,000
2nd Prize...\$2,500 3rd Prize...\$1,000
4th Prize...\$500
Plus 10 Prizes of \$100 each

CONTEST RULES

1 All entries must be accompanied by a filled-in entry form which can be secured by mailing coupon at right, or by writing to POPULAR SCIENCE Anti-Car-Theft Device Competition, 355 Lexington Ave., New York, N. Y. 10017.

A stamped and self-addressed envelope must accompany each request.

The completed entry form will warrant that to the

best of your knowledge the submitted device represents your own original idea and that it does not infringe upon any existing U.S. patent.

2 All entries must be working models of devices that can be attached to or built into a car to prevent its being driven away under its own power by unauthorized persons.

3 The device should require as little effort on the part of a driver as possible to render the vehicle undrivable to unauthorized persons.

How to choke off one of these to stop a thief?

Some entries have been standard commercial devices purchased in the open market! Some entrants have submitted copies of patents issued before the Competition started, and thus clearly are not sparked by the combined efforts of Popular Science and Allstate to find a deterrent to car theft.

Don't send too much. Then there are the over-zealous entrants who send in the actual parts of the automobile upon which their devices are to act. Submit only your actual invention, a duplicate of what your device would look like if eventually it were sold on the open market.

Fancy finish is not important. How well your invention performs is. The judges will take into account the fact that most entries are the products of home workshops, which may not have the facilities for that final polish.

And you will obviously be forced into certain compromises by the very nature of modelmaking—this, too, the judges will understand. For instance, a component that might be a simple metal stamping in a commercial version of your idea may have to be machined or built up from soldered pieces. Again, if your baby

really does the job, there is no need for you to worry about it.

Competition entries that survive the weeding-out and reach the finals will have to prove their mettle in an actual automobile under normal operating conditions. This should make it clear that mere ideas or simulations cannot expect to reap a reward.

Organize the steps. If I were competing for the prizes, I would divide my effort into the following steps: (1) I would tap all sources to get a clear idea of the problem; (2) I would check what others have done so that I would avoid useless duplication; (3) I would break the over-all problem down into separate digestible steps; (4) I would invent a solution for each step; (5) I would try to circumvent each solution and correct the loopholes; (6) I would combine the corrected solutions into a final package and; (7) I would dress up the new baby to be attractive to purchasers insofar as possible in my workshop.

That's my method—maybe it will help you. Your target is \$20,000, and money like that behooves that you take a straight and careful aim. PS

1 The device should be designed so that it can be mass-produced cheaply, and the estimated manufactured price will be taken into account by our judges in awarding prizes.

2 Each entry must be sent by insured mail. A self-addressed label and sufficient postage must be enclosed with all devices the owners wish to be returned. POPULAR SCIENCE will use its best efforts to return all inventions entered in the competition, but will not be responsible or otherwise liable for any inventions that are not returned.

3 Entries must be mailed to POPULAR SCIENCE Anti-Car-Theft Device Competition, P.O. Box 72, Murray Hill, N.J. 07974.

4 All entries must be postmarked no later than December 31, 1969, and received no later than January 10, 1970, to be eligible.

5 You may submit as many devices as you wish; each entry must be sent in a separate container, and with a separate entry form.

6 Winners will be selected by a judging panel of seven experts, whose decision will be final. Winners will be notified by mail.

7 Any U.S. resident may enter the POPULAR SCIENCE Anti-Car-Theft Device Competition,

except employees of POPULAR SCIENCE MONTHLY (and their families), of Allstate Insurance Co. (and their families) and/or their advertising agencies, or where prohibited by state or local laws or regulations. Taxes on prizes are the responsibility of winners.

Send for Your Entry Form

Please send me an entry form so that I may enter the POPULAR SCIENCE Anti-Car-Theft Device Competition, sponsored by Allstate. I enclose a stamped, self-addressed envelope.

Name _____

Address _____

City _____ State _____ Zip _____

Inventors' Competition

POPULAR SCIENCE MONTHLY

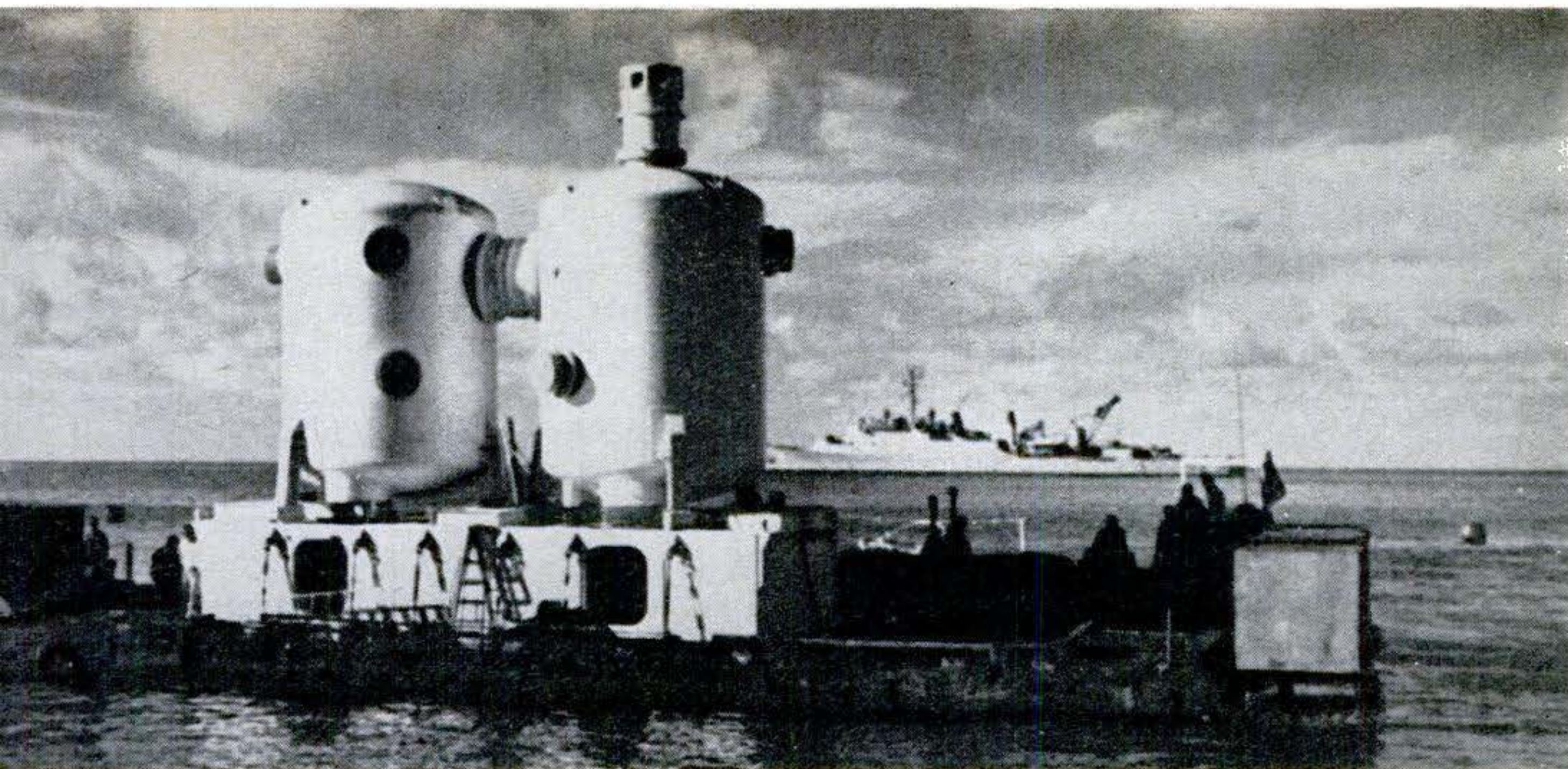
355 Lexington Ave., New York, N.Y. 10017

Under the waves for 60 days — **TEKTITE REVISITED**

By STEVEN M. SPENCER



Last December, PS previewed this amazing adventure. Now we tell what it feels like to live underwater for two months.



Tektite I floats in Lameshur Bay, off St. John in the Virgin Islands (above), before being submerged. On facing page aquanaut peers into one of six portholes.

The four young scientists woke each morning to sunlight dancing down through shuttling throngs of silver-gray needlefish. From plastic portholes they looked out on schools of yellow snappers grazing on the living coral walls that fenced off their Caribbean underwater home. After breakfast, strapping on scuba gear, the men emerged from the shark-proof front vestibule to swim shoulder to fin with others of their neighbors—mackerel and amberjacks, blue-green parrot fish, and gaudily striped demoiselles.

This was the exotic setting of a project called Tektite I. For 60 days (twice as long as any previous dive), the four ocean scientists of the U.S. Department of the Interior lived and swam on the bottom of Lameshur Bay, off St. John in the Virgin Islands National Park. Not once, from February 15 to April 15, did they come up for air. They proved that men can remain in good physical and psychological health while living like fish among the fishes for prolonged periods—and do useful work. They also demonstrated that the best way to study the ocean environment in its hour-to-hour changes is to become an intimate and semipermanent part of it.

Dry clothes and TV dinners. Home for the Tektite scientists was a tight little duplex standing in 47 feet of opalescent green water on a sandy area 300 feet from shore. Surrounding it were six-foot-high

walls of coral profusely overgrown with marine life—sea fans, sea whips, vivid-hued sponges—like an underwater rock garden. Beyond were more reef formations, many rising 15 feet from the bottom. As the men vaulted over these ridges, propelling themselves with flippered feet, they emerged onto a plain that sloped away to the outer depths of the bay.

The undersea house consisted of two cylindrical steel tanks, each 18 feet high, connected by a crawl-way tunnel and mounted on a base structure firmly anchored to the ocean bottom with 87 tons of lead ballast. Each tank contained two rooms, one above the other. Painted white, the habitat attracted hundreds of fish, which night and day swam up to peer into the portholes.

In one of the lower rooms—comfortably furnished, wall-to-wall carpeted—the men slept and ate, read, listened to tape-recorded music.

An upper room, the bridge, held the communication controls and laboratory equipment. Another room housed transformers, air-conditioning compressors, and a freezer locker for food. (TV dinners were often on the menu, but fresh fruit and vegetables were occasionally sent down from the surface in a sealed pressure pot on a dumbwaiter line.) The fourth chamber, the “wet room,” opened directly

Continued

"For a marine scientist, there is no place like a

into the sea via a vertical hatch. Here the men kept their scuba gear and diving suits, and here after each swim they showered with fresh water and changed into dry clothes—usually shorts and T-shirts.

The aquanauts were connected to the support barge through a thick "umbilical," a bundle of hoses and cables. These brought the fresh water, air, and electric power, as well as various communication lines.

The project was jointly sponsored by the U.S. Navy, the Department of the Interior, the National Aeronautics and Space Agency, and General Electric which designed, built, and equipped the under-sea house for \$500,000. The total cost, less than \$3 million, included construction of a base camp on St. John to house a 100-man support crew.

The main purpose of the program was to establish guidelines for future long-term research projects from submerged laboratories. NASA's interest, stimulated two years ago by Astronaut Scott Carpenter after he joined the Navy's Sealab diving project, was to observe the behavior of men confined for long periods in small, semi-isolated quarters.

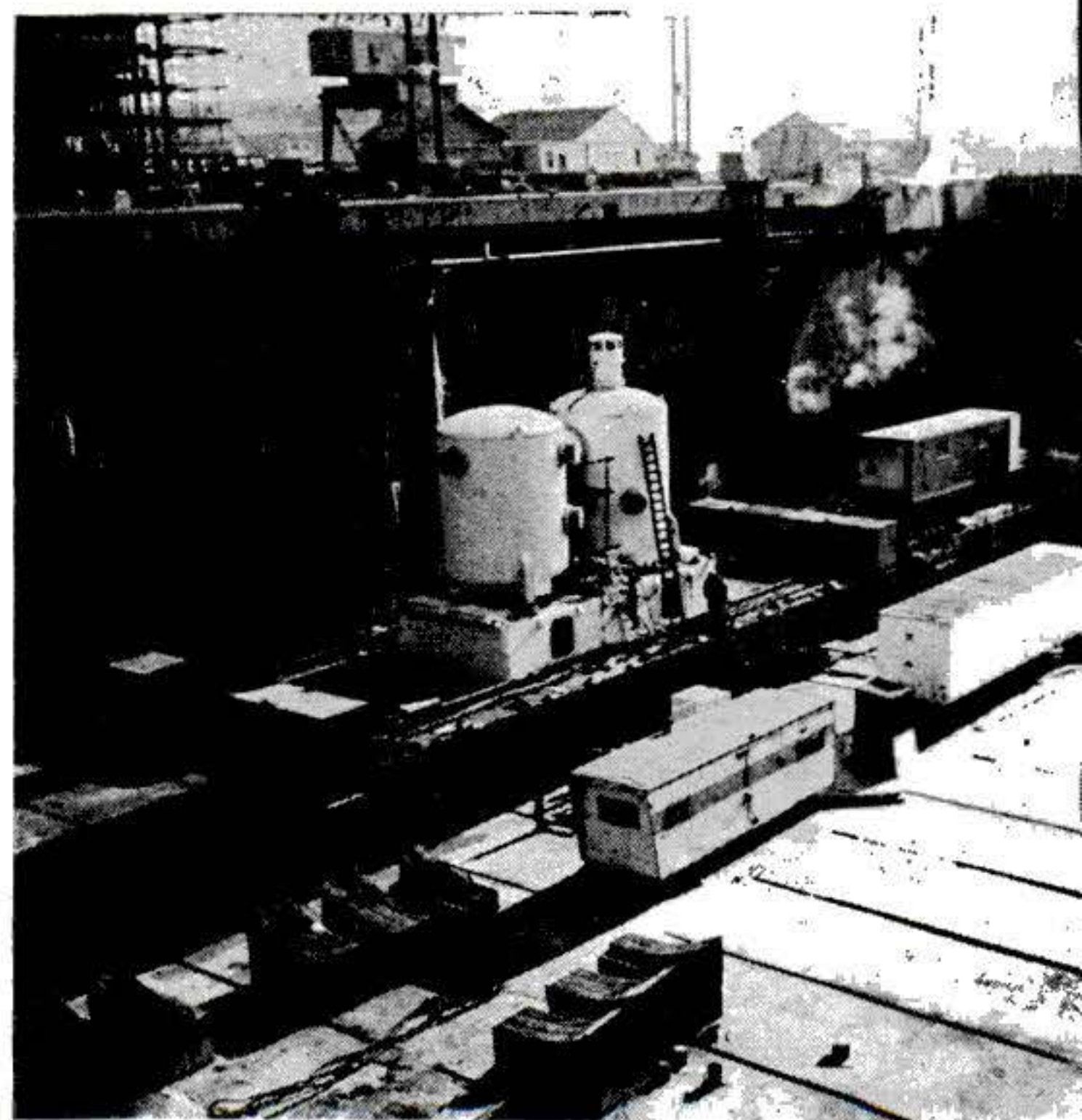
The Tektite crew chief was Richard A. Waller, 35, formerly an oceanographer in the Bureau of Commercial Fisheries. His teammates were Conrad V. W. Mahnken, 32, and John VanDerwalker, 33, both biologists with the BCF, and Dr. H. Edward Clifton, 34, a geologist with the U.S. Geological Survey.

Diving and health. There were many scientific gains. One of Tektite's contributions is the mass of detailed information it developed on "saturation diving," a procedure which permits longer dives. When the diver is submerged and breathing air under pressure for any length of time, his body tissues become completely saturated with the gas that dilutes the life-sustaining oxygen. (For dives of less than 100 or 150 feet, this is nitrogen; for deeper dives, helium.) Once a diver's tissues are even partially saturated, he must undergo gradual decompression before surfacing. Otherwise the nitrogen or helium, suddenly released from pressure, forms bubbles in his blood vessels,

muscles, and around the nerves, and he will suffer from the bends, with painful or fatal consequences. The advantage of the Tektite dive was that the men had to decompress or desaturate their tissues—a procedure that required them to remain in a large decompression tank for 19 hours and 22 minutes—only once, at the end of their two months underwater, instead of after each excursion.

Since oxygen, as well as nitrogen, can be toxic at abnormally high concentrations, the habitat had been supplied with a mixture of only eight percent oxygen and 92 percent nitrogen. Since the normal proportion we breathe at sea level is 20 to 80, it would appear the aquanauts were short-changed on oxygen. But at the habitat pressure—36 pounds per square inch, or more than twice normal—the air was concentrated just enough to give the men the normal number of oxygen molecules per breath.

How would the divers' lungs be affected by the extra effort of inhaling and exhaling air twice as heavy as normal air, continuously, night and day, for two months? Surprisingly, the men were not aware of any extra breathing effort. Nor did the most detailed respiratory studies reveal any changes in lung tissues. These and other tests made to detect alterations in



Twin-towered Tektite takes shape at General Electric's Missile and Space Division in Valley Forge, Pa.

Underwater home."

blood, skin, hearing, vision, and sense of balance, were carried out by a team of doctors under the direction of Dr. Christian J. Lambertsen, professor of pharmacology at the University of Pennsylvania. "What was important in the Tektite biomedical tests," Dr. Lambertsen said, "is that there were no important changes at all—pulmonary, cardiac, or neurological."

The aquanauts made daily physical checks—pulse, blood pressure, electrocardiograph readings. At night they put on "Snoopy caps"—electrodes—to record their brain waves, which would show how well they slept. In fact, it would have been impossible for any of the crew to have suffered so much as a bruised toe or a touch of homesickness without the fact being observed and recorded. For, topside in the control barge, doctors and "behavior monitors" sat before a bank of closed-circuit TV screens and open microphones, keeping the men under round-the-clock surveillance. A detailed log was kept on computer cards of how much food each man ate, how he spent his time—working, reading, talking to crew-mates, loafing, or withdrawing to his bunk.

The purpose was to assure the safety of the aquanauts, and to provide NASA with information on how to judge crew compatibility and "group cohesiveness"—vital during any long space voyage. Happily, the four men in the Tektite duplex were most compatible.

In the eerie stillness of their undersea world nearly every experience was unusual, and each change of light or weather brought new rewards to the senses. A severe thunderstorm struck with 50-mile-an-hour fury on the 13th day of the aquanauts' immersion and dumped four inches of rain on their bay. Peering up at the black skies from under the tossing waters, the men got a rare and spectacular view of the lightning flashes.

"From our position in the habitat we couldn't tell, by looking, how high the waves were," Conrad Mahnken said. "But



Virgin Islands site was chosen because of crystal-clear water and abundance of marine life. Here, aquanaut encounters inquisitive ray.

as they rose above us the increased pressure raised the water level in the open hatch, and we could feel this as a pressure surge in our ears."

The swimmers occasionally ranged as far as 1,800 feet from home, and averaged two hours a day per man in the water, often staying in five hours.

"This was more diving time than we could have had if we'd been working from the surface," crew-chief Waller explained. "In non-decompression diving down to depths of 50 feet you are limited to 100 minutes for the first dive. Then you must wait three or four hours before a second dive, which can be only 60 minutes. And after that you have to wait 24 hours before going down again."

Nevertheless, the Tektite men felt their style as free-ranging underwater researchers was cramped by the limited capacity of their Scuba tanks. Every 45 minutes they would have to return to the habitat, or to a way-station, for a refill of air.

"To spend so much time in travel and in recharging bottles was frustrating," Waller remarked. "Our most serious mistake in planning was in not providing ourselves with a more advanced type of breathing apparatus, a completely closed recycling type that would have given us four hours at a time, instead of less than an hour." Several experimental models were on test by the Navy when the Tektite mission began, but the tests were not finished.

A closed-circuit breathing pack would

[\[Continued on page 202\]](#)

AIR BAGS: Will They Help You Survive

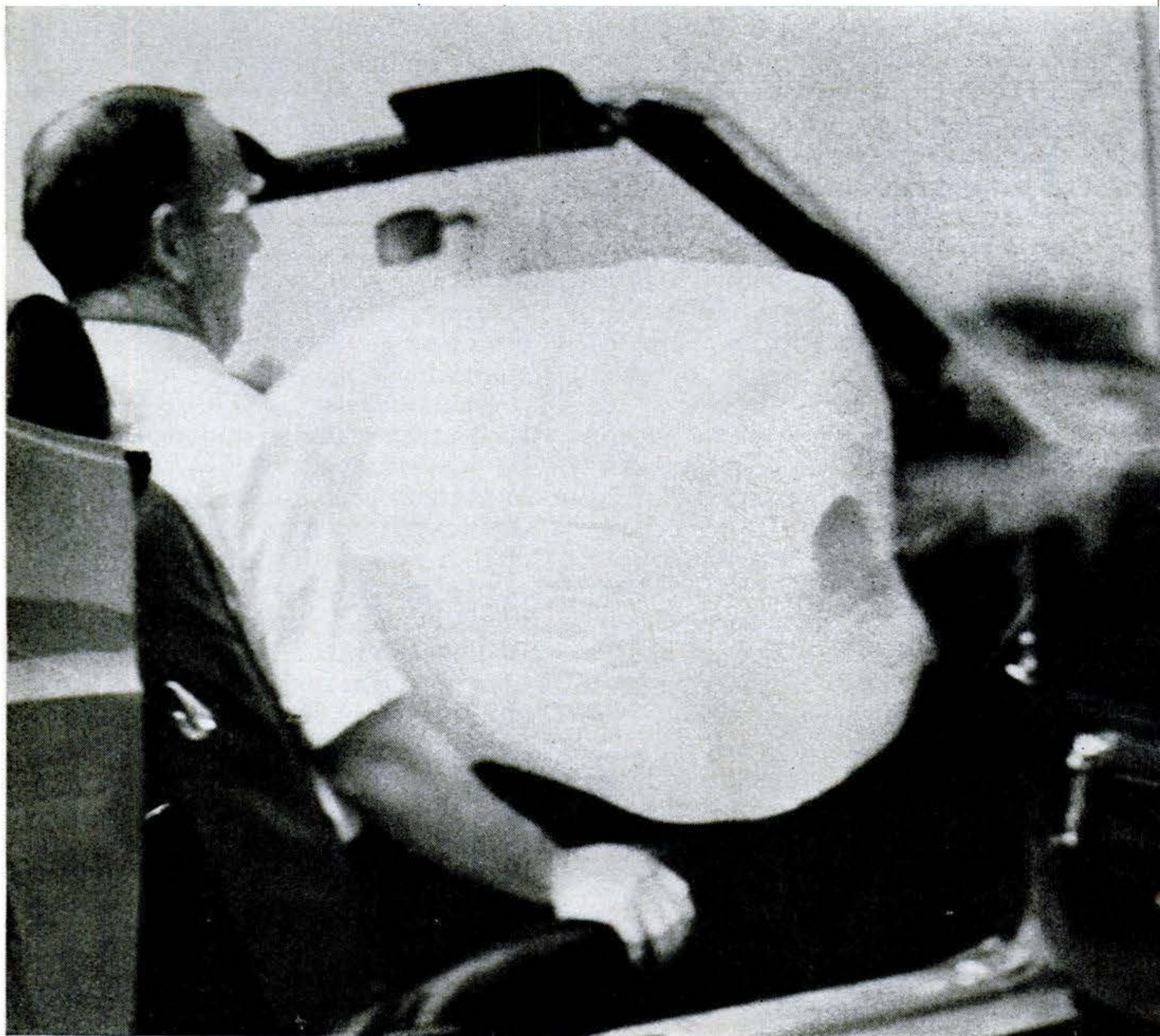
Some '71 cars will have them; they may be required in '72 by Federal Auto Safety Standards

**By JAN P. NORBYE / PS Automotive Editor
and JIM DUNNE / PS Detroit Editor**

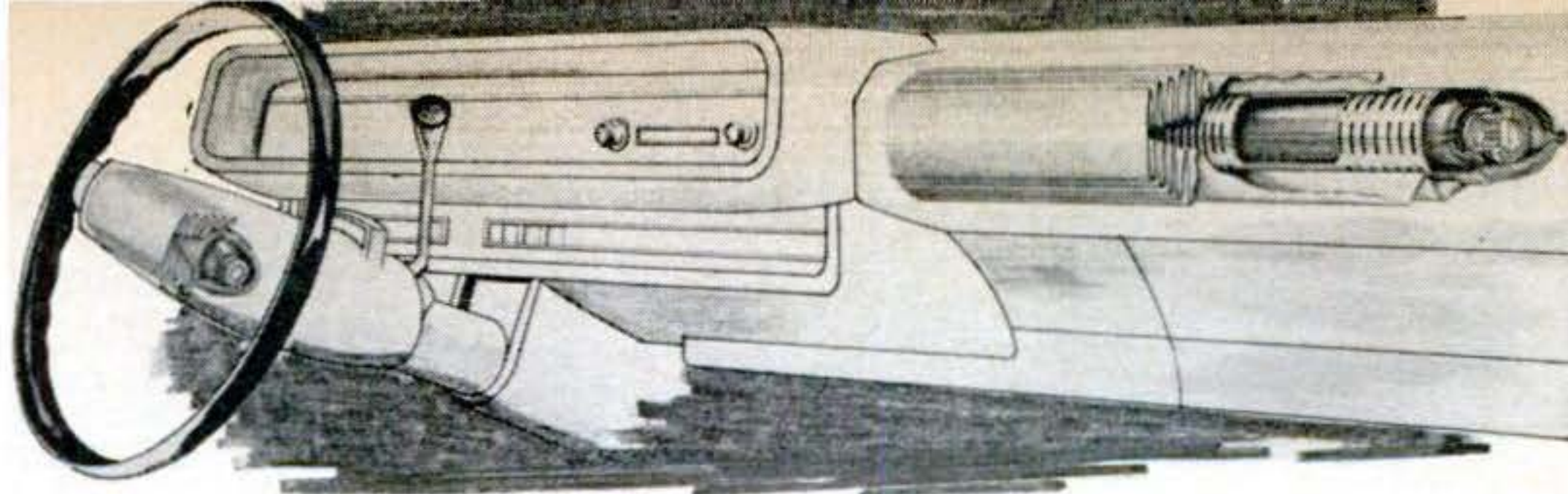
Triggered manually from outside the car for test, pillow pins Jim Dunne to the driver's seat. At this point of full inflation, air is beginning to escape

Crash! And suddenly, out of nowhere comes this balloon that keeps you safely in your seat; the dreaded "second collision" after impact—when your body hits the steering wheel, windshield, or whatever is in front of you—is averted. And that second collision is the killer.

through the large vent holes in the two sides of the pillow. Half a second after detonation, the bag will be wholly deflated, as it was before.



folded pillow and gas reservoir are contained behind soft padding inside the dash panel on the passenger side; smaller unit inside steering-wheel hub on driver's side.



Fatal? Car Crashes?

The idea of an inflatable pillow that emerges at the moment of impact has been around for a long time. Eaton, Yale & Towne have spent some three years and one-and-a-half million dollars to develop a workable system. But is it practical? How well does it work? Can it fail? Or

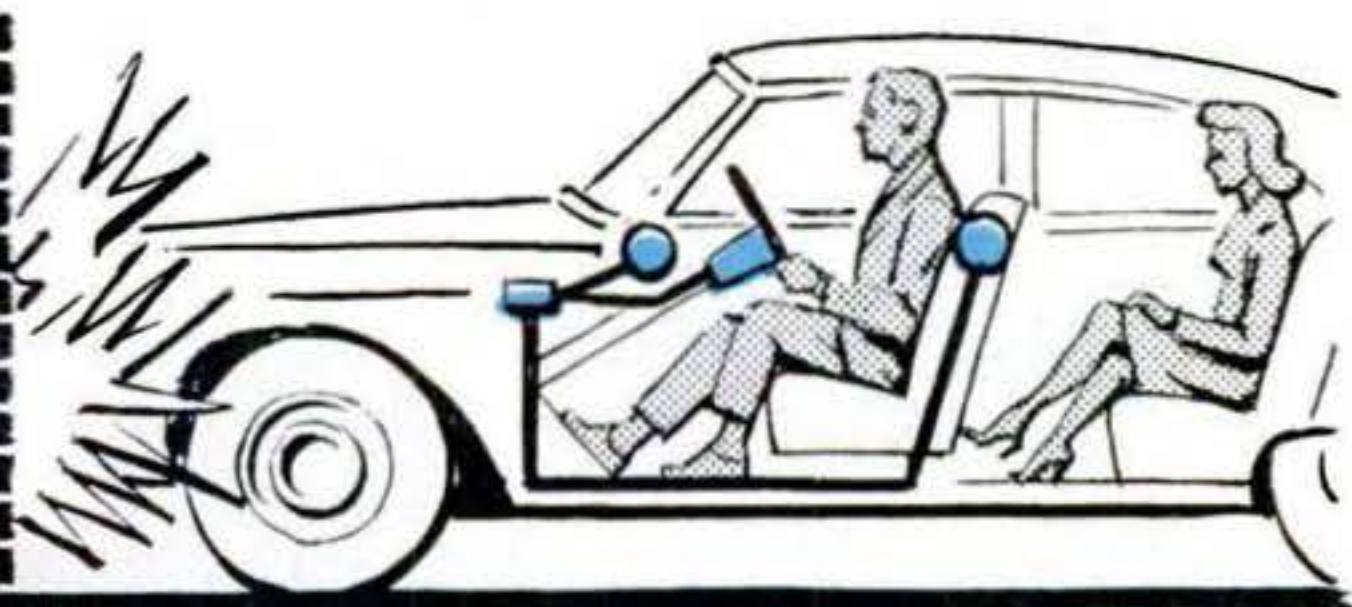
is there a risk of activating it unintentionally? To get the answers to these and further questions, we went to Eaton, Yale & Towne for a test. And we came away impressed with three facts:

1) The Auto-Ceptor air-pillow system

Continued

The whole thing happens quicker than the eye can follow

Instant of impact



Front end begins to crumple

1/50 second after impact



Sensor triggers air-pillow inflation

1/25 second after impact



Pillows reach full inflation

1/15 second after impact



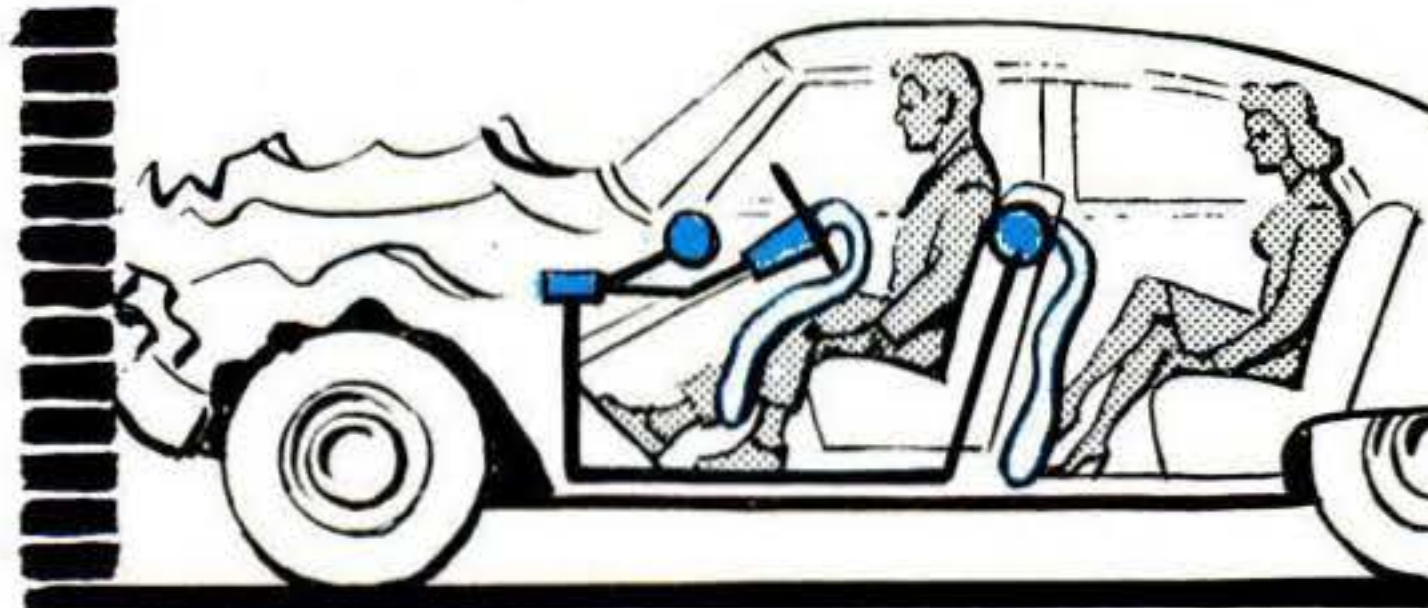
Occupants are thrown forward

1/10 second after impact



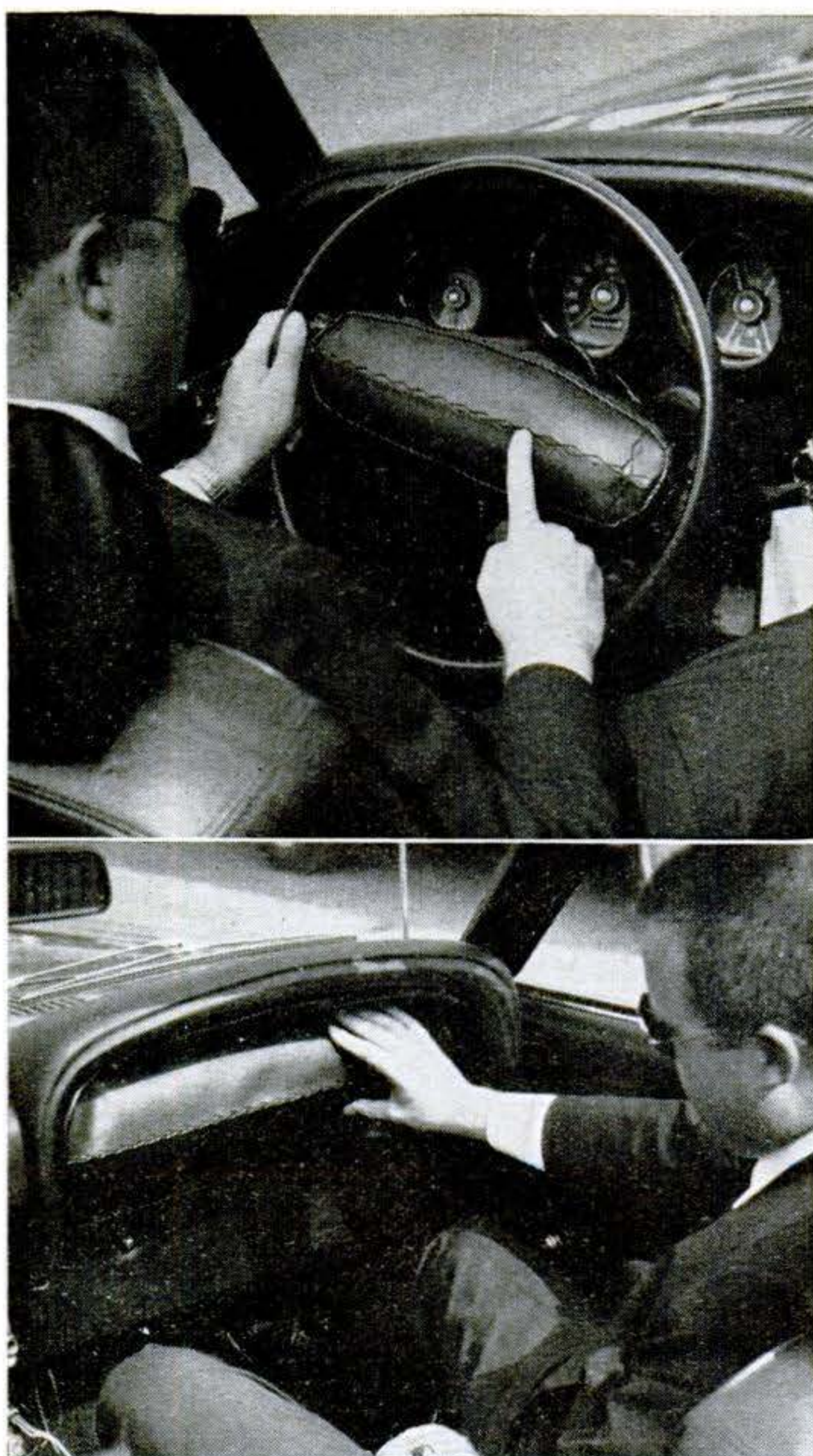
Air pillows pin them back in seats

1/2 second after impact



Pillows deflate; occupants are saved

Air pillows beat shoulder straps—they're automatic and



Installation is neat and compact, as shown in this Mustang. In top photo, Norbye's finger points to seam that bursts when bag is inflated. Cover is designed to withstand normal wear for five years.



Developer of the air pillow, Charles Simon of Eaton, Yale & Towne, demonstrates the rapid deflation. The pillow is made of a woven nylon fabric and is designed for fail-safe five-year storage.

offers protection unmatched by any other type of restraint.

2) The system is fully automatic. No decision or action by the driver or passengers is called for.

3) The pillows are stored out of sight in specially sealed "pockets" until the moment they are needed, and require no maintenance.

Before we explain how these facts were proved to us, we'll tell you how the Auto Ceptor system works.

The folded air pillow is attached to a steel reservoir containing an inert gas (nitrogen) pressurized at 2,500 p.s.i. A detonator explodes a metal diaphragm that functions as a valve between the reservoir and the diffuser tube when triggered electrically by a sensor mounted on the front wall. The steel reservoir is no larger than a flashlight, and the diffuser is a small tube with a series of holes disposed radially, fitted along the pillow's front edge.

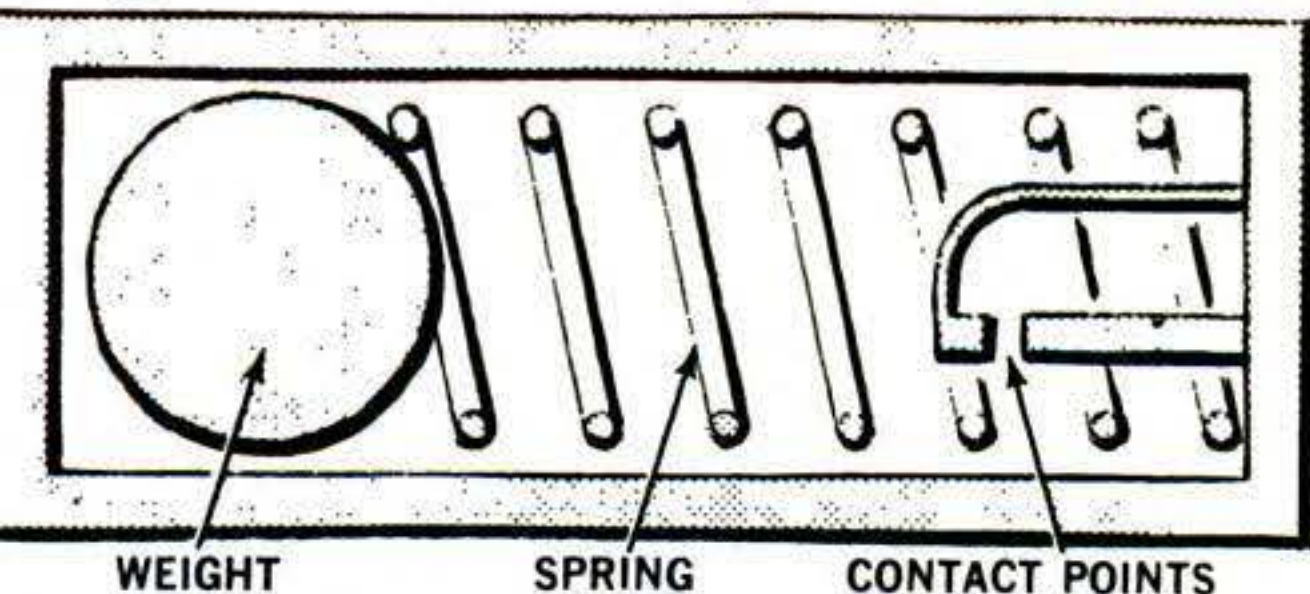
The sensor: It's the key to the whole system. It does not cause inflation of the air bag when the bumper hits something, when the fender gets bent beyond a certain point, when you slam over railroad tracks, or when you came to a sudden panic stop.

The sensor is designed to feel the inertial force of the crash, just the way your body would feel it. How is it done? The sensor responds to deceleration in the vehicle as a whole, and above a certain limit, it will send a signal to the detonator. Smaller than an ignition coil, the sensor contains a ball, a coil spring, and a set of electrical contact points. The spring holds the ball in place, but extreme deceleration will drive the ball to compress the spring and create contact in the points. This closes an electrical circuit which triggers the detonator.

The spring is strong enough to resist loads below five g's—that's equivalent to an 8-10-m.p.h. barrier crash. Even in a panic stop, with all four wheels locked, you don't get much beyond one g.

If the car hits a mailbox or a traffic sign, the sensor won't react. But if the car hits something solid, the signal will be sent. When the ball travels $\frac{1}{2}$ inch in 7-10 milliseconds, the sensor knows there's been a collision.

sight until they're needed



The sensor that sets off the detonator is mounted on the firewall, under the hood. The sketch shows how it works. The weight, reacting to inertia loads, will compress the spring and close an electric circuit at the contact points. To bring the weight that far, impact loads of five g's are needed.

When the collision is happening, you have no time to fasten seat belts. Can the air pillow be inflated in time to be of any value? Yes, sir. It will reach full inflation in 1/25 second. That's before your body is really going anywhere, thanks to some impact absorption in the frame and sheet metal ahead of you.

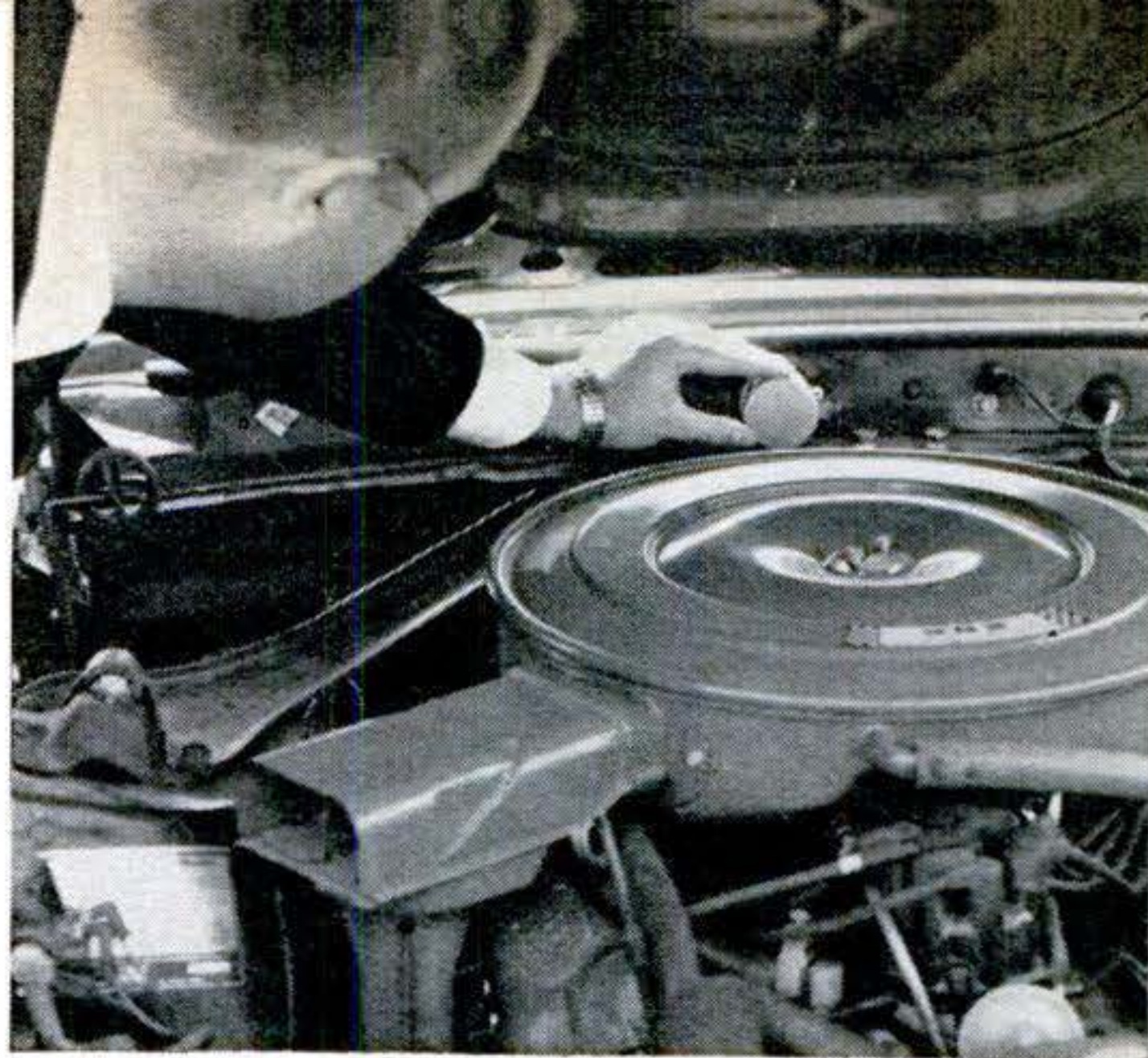
Immediately after full inflation, the gas begins to escape through blowout patches on either side of the pillow, and the occupants experience a cushioned impact with minimum rebound.

All-around installation. Air bags can be installed for all passengers. In front, in place of the glove box; in back, inside the front-seat backs. For the driver, in the steering wheel hub.

But back to the sensor. You realize, of course, that not all crashes are head-on. But 67 percent of fatal accidents occur within a 60-degree arc centered on the straight-ahead line. The sensor is designed to react to impact forces throughout a sector extending 30 degrees to each side.

Charles Simon, who developed the Auto-Ceptor system, points out that it does not replace lap belts. Lap belts are necessary to prevent ejection in a variety of crash situations, and to keep occupants from being thrown across the interior in roll-over accidents. But it certainly does away with the need for shoulder belts (upper torso restraints). It has none of their drawbacks—risk of neck injuries, strangulation, clavicle fractures, etc.

Will it be effective at high speeds? Barrier crash tests with dummies indicate survival up to 40 m.p.h. Disappointed? But wait a minute! That's a barrier test,



against an immovable solid object. In a head-on crash between two cars, the Auto-Ceptor promises survival up to 60-65 m.p.h. How come? It's because the crumpling of the sheet metal *on both cars* helps cushion the impact (reducing the severity of the collision to the equivalent of a 40-m.p.h. barrier crash).

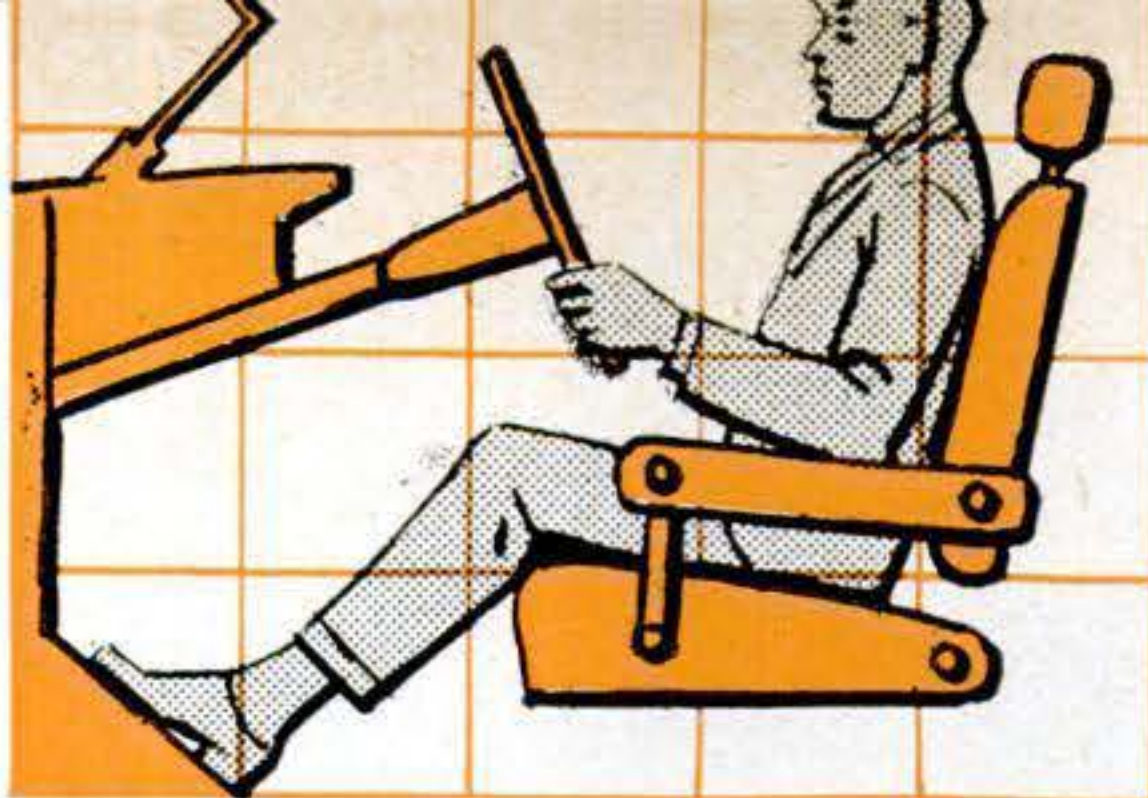
Ford Motor Co. has been working with Eaton, Yale & Towne for about two years on the development of a production version of the Auto-Ceptor. Ford tested the air pillows on a number of cars for sled and barrier crash tests, and has been so satisfied with the results that an Auto-Ceptor unit may be standard (for front-seat passengers) on the '71 Mercury Marquis (see Detroit Report, this issue).

What lies ahead. It may become a legal requirement for all new cars as early as '72. Whether the Department of Transportation is talking about the front seats only, or all around, has not yet been made clear. Rear-seat passengers may need air bags less, because they receive some protection from the front-seat backs. The driver? He is protected to some extent by the steering wheel as the column collapses under the impact force.

Can the system fail to act in a collision? Failure is unlikely because of the sheer simplicity of the system. Charles Simon told us that the system on the Mustang we used for our test had been activated between 400 and 500 times without a misfire. This test unit, like most others, had double sets of wires between the sensor switch and the detonator switch.

What about accidental activation? Ford has not had a single case of unintentional

Continued



The barrier-type seat

The idea of the barrier-type seat is to keep the occupants of a car in place without belts of any type, as shown in this sequence of sketches. Automatic seat action could be triggered by the same type of sensor that is used with air pillows. In a crash with 15g deceleration, it would take $\frac{1}{25}$ second to release the bottom of the seat and begin to lift the armrests. In $\frac{1}{12}$ second, the steering wheel would be bent out of the way, and only $\frac{1}{8}$ second after impact, the driver would be securely cradled.

inflation of the air bag in over two million miles of road testing. The crash situation that will make the sensor react apparently cannot be simulated in any braking or maneuvering action without actually crashing!

How does it feel when the bag suddenly appears in front of you? You have no time to feel anything—it all happens too quickly. We made our test with the vehicle at standstill, and the passenger was not catapulted forward as he would have been in a true accident. The inflation was triggered manually, from outside the car (with separate wiring). The report from the detonator and the rush of the escaping gas were more startling than the appearance of the bag. The more severe the crash, the higher the pressure of your body against the pillow.

In high-speed accidents, we're talking about survival—not bruises and shock. In a stationary demonstration, by the time you realize that the bag is there, most of the gas has already escaped. Deflation is immediate. The whole cycle, from impact to deflation, takes half a second. In an actual crash, the pillow will have collapsed when the wreck comes to complete rest, and your freedom to move your head and arms will then be unrestricted.

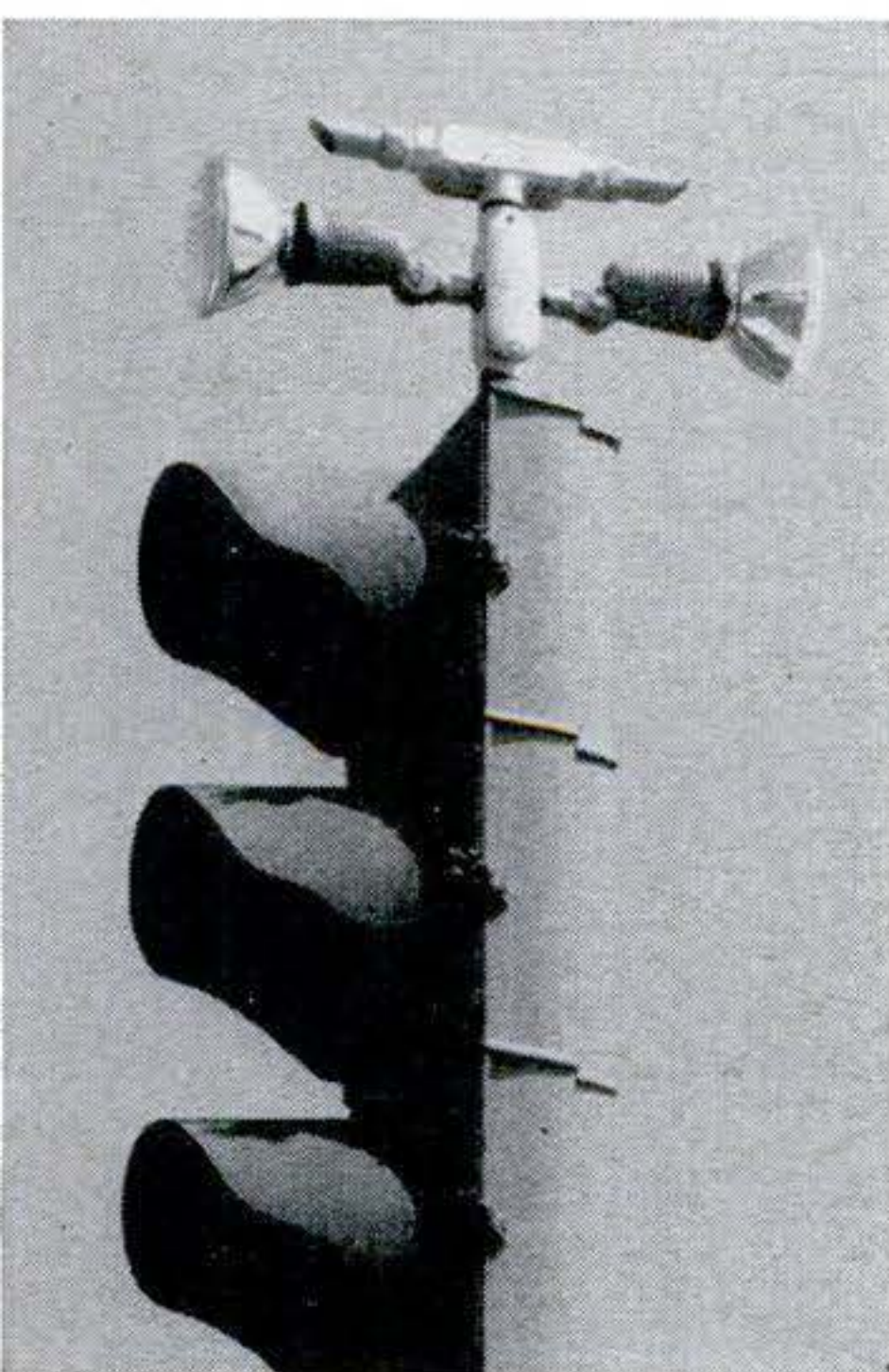
Can the pillow be re-used? Current proposals call for replacement of the entire unit when a wrecked car is repaired and put back on the road. Since it is a safety device, and a new one at that, the manufacturers want to limit all possibilities of error. Repacking these bags must be a little like repacking parachutes!

What will it cost? Both Ford and Eaton, Yale & Towne are tight-lipped. Let's see: The bag is made of urethane-coated nylon, cut and sewn to specific size. The reservoir and diffuser tube are made of steel. Nitrogen gas is quite cheap. Minor components don't add up to much. We think the whole package could probably be sold for under \$50 retail.

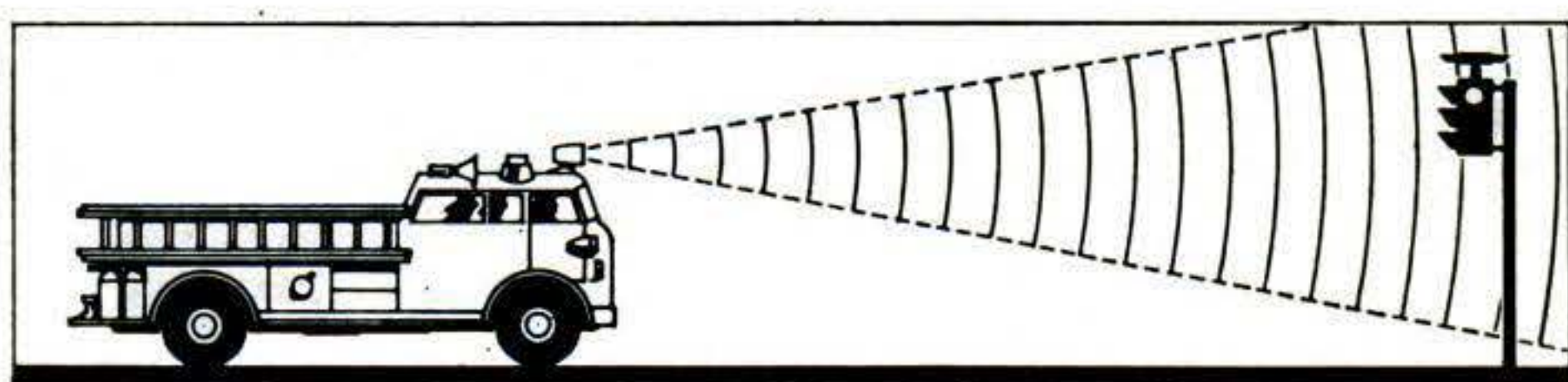
Is there time for Detroit to complete the necessary redesign and tooling work if the present proposal goes through, making a federal standard including air pillows obligatory with effect from January 1st, 1972? We're guessing they're well along with their preparations. Whether enough suppliers with enough capacity can be found is another matter.

Fire Engine Has a Built-In Traffic Cop

Fire truck speeds down street (below) after giving itself green light. How? By using optical transmitter located on top of cab, and shown held by fireman at right.



Flashes of light from fire truck (sketch) signal detector on traffic light to go to green. Device also turns on lights below detector to let driver know he is in control.



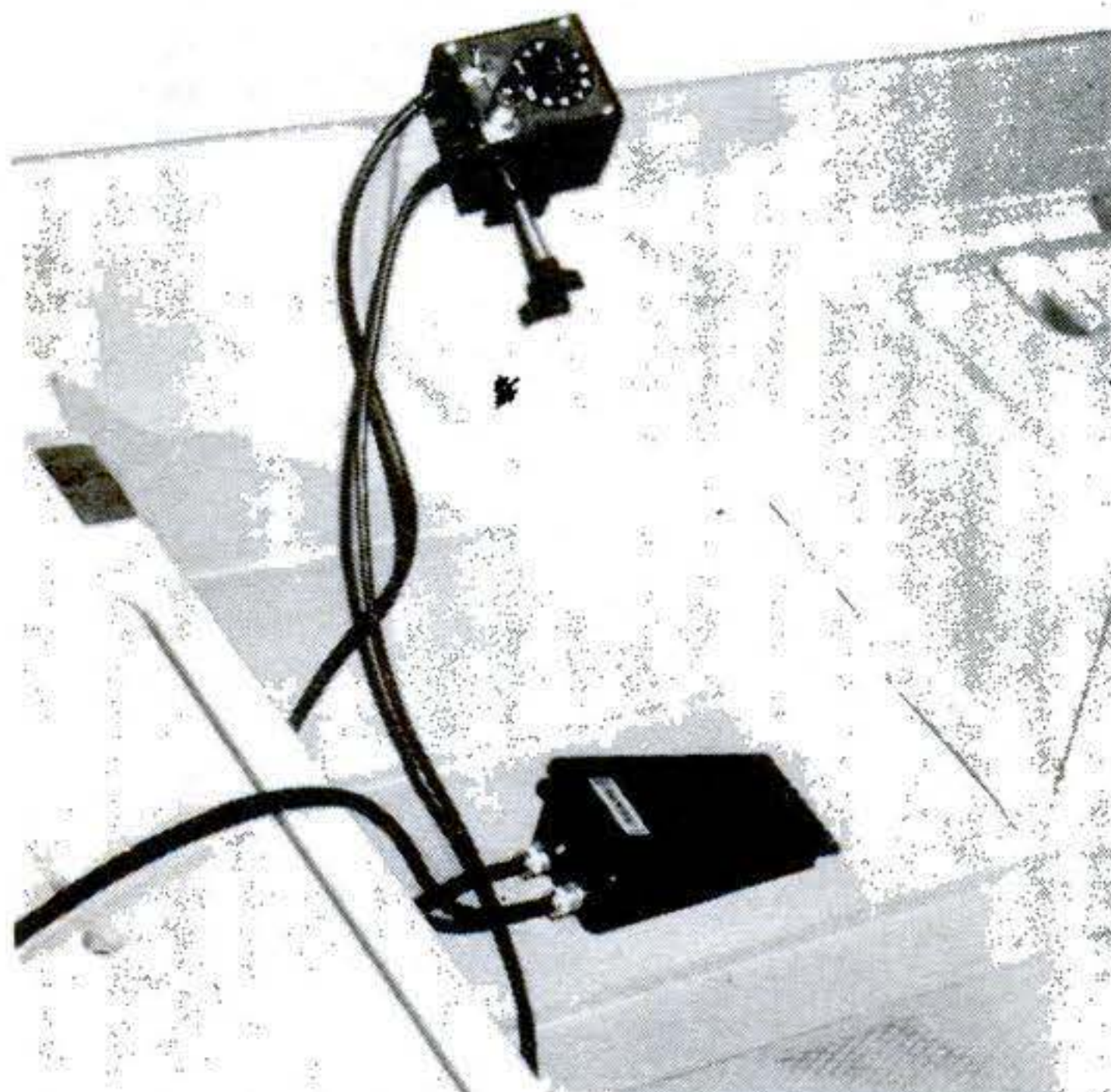
Emergency vehicles are saving precious minutes in responding to fires and other hurry-up calls with the aid of a new system that gives them a green light on their demand. The 3M Opticom (optical communications) system turns traffic lights green in the direction a fire engine, police car, or ambulance, is heading. This keeps traffic flowing freely and keeps other vehicles from entering the street until the emergency vehicle speeds by.

The system is triggered by a pulsating optical transmitter mounted on—say—a fire truck. A beam detector on the traffic signal picks up the flashes and feeds them into a phase selector, which decodes and relays them to change signals. A second vehicle cannot override the first signal, but waits its turn. The light stays green for five seconds after the emergency vehicle passes. The system is now in use in several cities.

Those Sneaky Little

Fishing or duck hunting, these silent motors help you stalk a trophy on his own terms

By DAVID D. VIGREN



You have pivotal steering and infinite speed control from any seat position with Sears' new remote electric. Night-light/cigar-lighter plug is included.

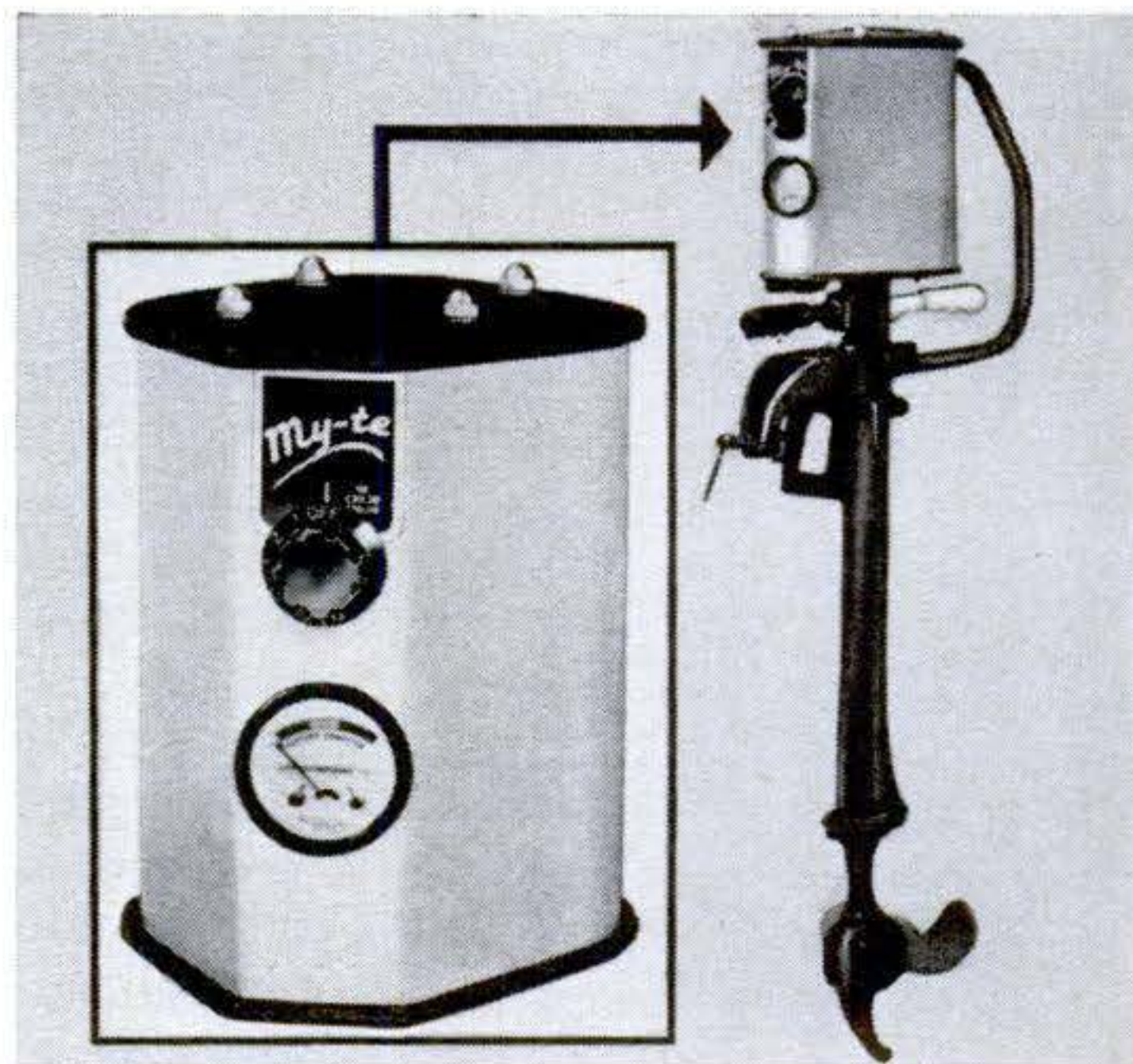


The new model 5926, shown in these photos, will reportedly move Sears' 12-foot Gamefisher boat from $1\frac{1}{4}$ to six m.p.h. (ideal trolling speeds). The movable bracket has seven tilt positions.

Popularity has come to the little electric trolling motor. After purring almost silently for 50 years in favor of serious fishermen, hunters, and marine science buffs, electrics are taking off. Even the mighty Sears catalog offers them.

New interest in electrics has been stirred up by better designs and a wider range of products. These trollers are more versatile, and—this is important—they will run longer on a battery charge.

Think electrics are only for slow dads? Anyone who admires good equipment gets the basic point right off. They're fun. If you haven't yet gotten a glimpse of one in action, brace yourself. You'll see a high-riding boat moving without sound or any apparent means of locomotion in water maybe six inches deep. Dead stop. And then it might move *sideways*, or sort of flow, beam-first, into



Unique battery meter on My-Te's motor housing tells you when to return to base. Tailoring speed settings to needs, and switching the motor off when possible will give you a longer go on one charge.

ELECTRIC TROLLERS



Perfect match: An electric like this 10-speed Tempo-Troll makes careful fishing easy for them.

deeper water. The sportsman can move in on the biggest fish in the lake without scaring them.

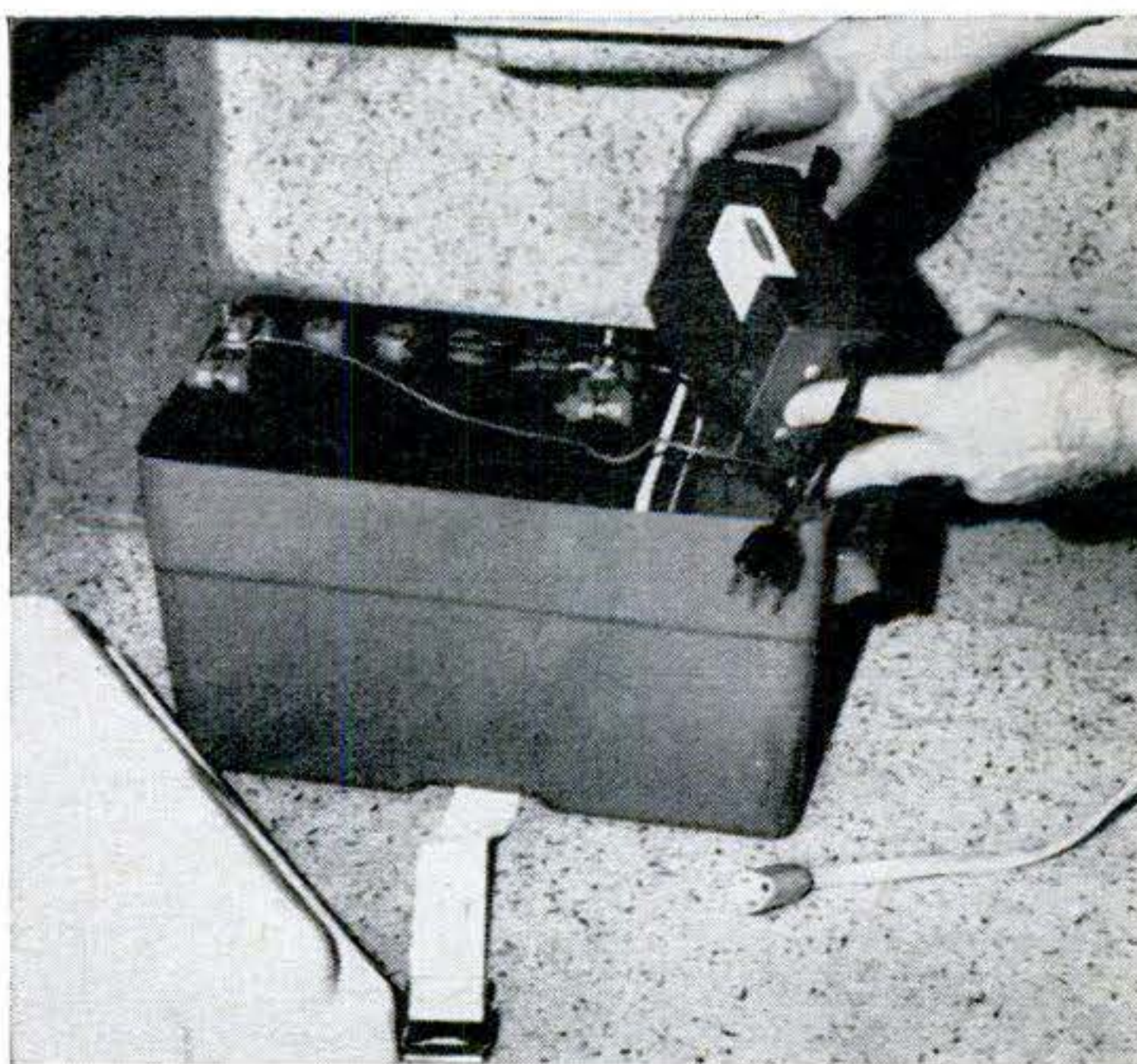
An electric puts your boat on casters. Move a foot at a time if you want to.

It takes the grouch out of careful fishing and hunting. Hunting duck or deer, you can shift position without showing an oar or making sound. Add a foot-operated remote control, and your hands are

Continued



Barracuda! Remote control will start, stop, reverse, select speeds, and steer Electra Pal's top-of-line. The Pike (right, above) has motor in head and curved shaft for working through thick weeds.



A combined battery box/charger for 12-v. battery, by Rubbermaid, is tight enough to keep out spray. Charge unit fits into one end; divider adjusts to battery size. Just plug it into 110-v. dockside outlet.

Electrics give you 360-degree maneuverability

entirely free for action. Teamed with a distance-covering outboard, it adds a safety margin for getting home.

Taking a closer look. You'll be surprised at the array of electric-motor characteristics available to meet your particular needs. Rangiest is the stalwart Minn-Kota model HGR. It's unique in that it operates on six, 12, 18, or 24 volts. It is also one of the most expensive—\$208.95 (complete with remote foot control). Here are specifics:

Speed	Volts	Amps		r.p.m.
		draw	thrust	
1st	6/12	4.8	4.3	609
2nd	6/12	6.8	5.7	710
3rd	12	10.8	8.2	825
1st	24	9.75	13.4	1,045
2nd	24	13.25	17.5	1,190
3rd	24	21.5	23.3	1,360

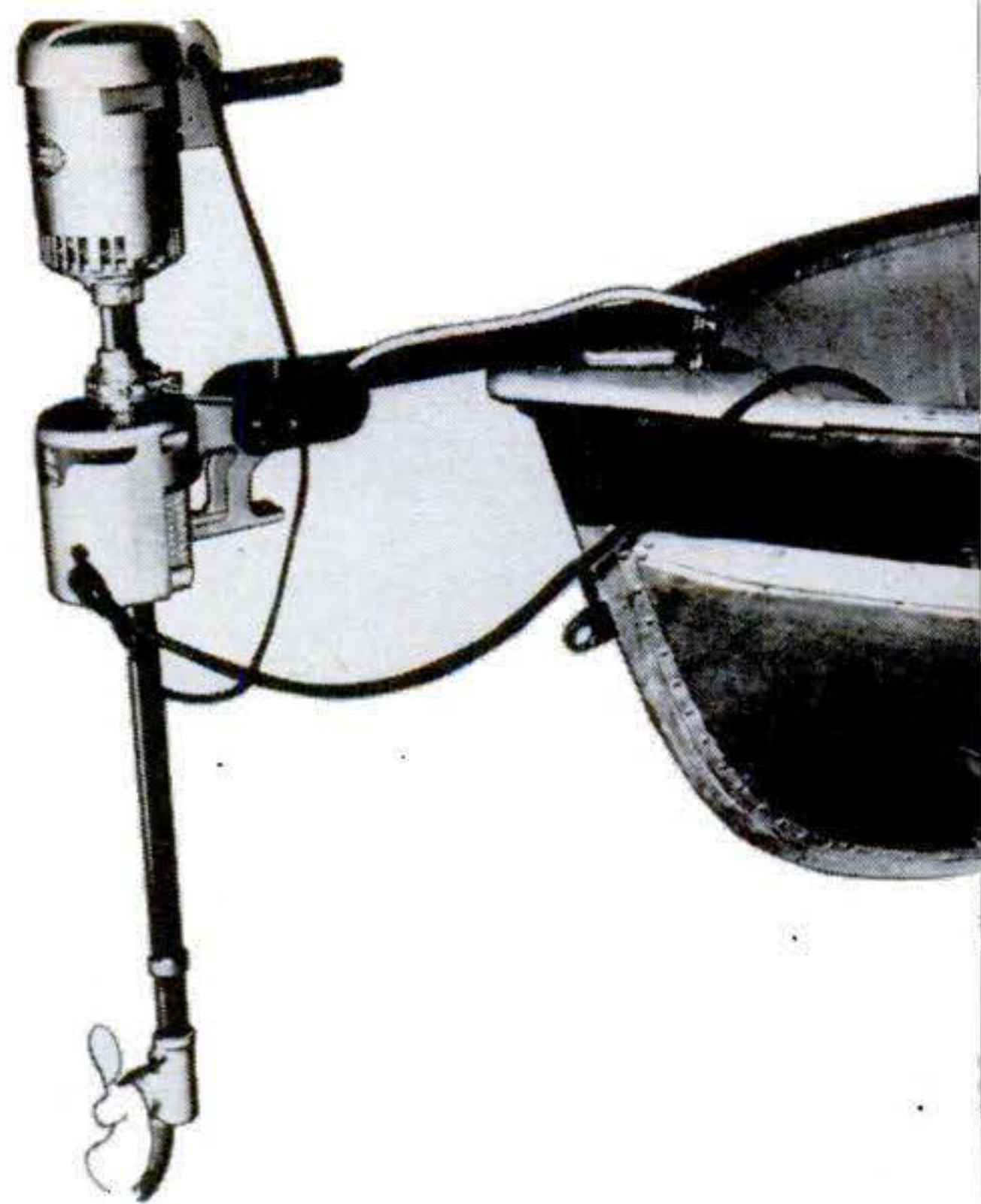
An altogether different type of machine is represented by the delightfully slim and lightweight Shakespeare Wonder-troll 101. It sells for only \$75, list:

Speed	Volts	Amps		r.p.m.
		draw	thrust	
low	6/12	6.	1.7	935
high	6/12	13.5	4.8	1,375

These characteristics indicate some of the things to consider when you look over the full range of trollers available on the market.

Most electrics now are wound for 12-volt power, and makers recommend a 12-volt, 60-amp battery for best operation. A characteristic motor will run at maximum 14 amps for about 4½ hours on a fully charged battery, but in practice you won't run it continuously—not at top amperage, anyhow.

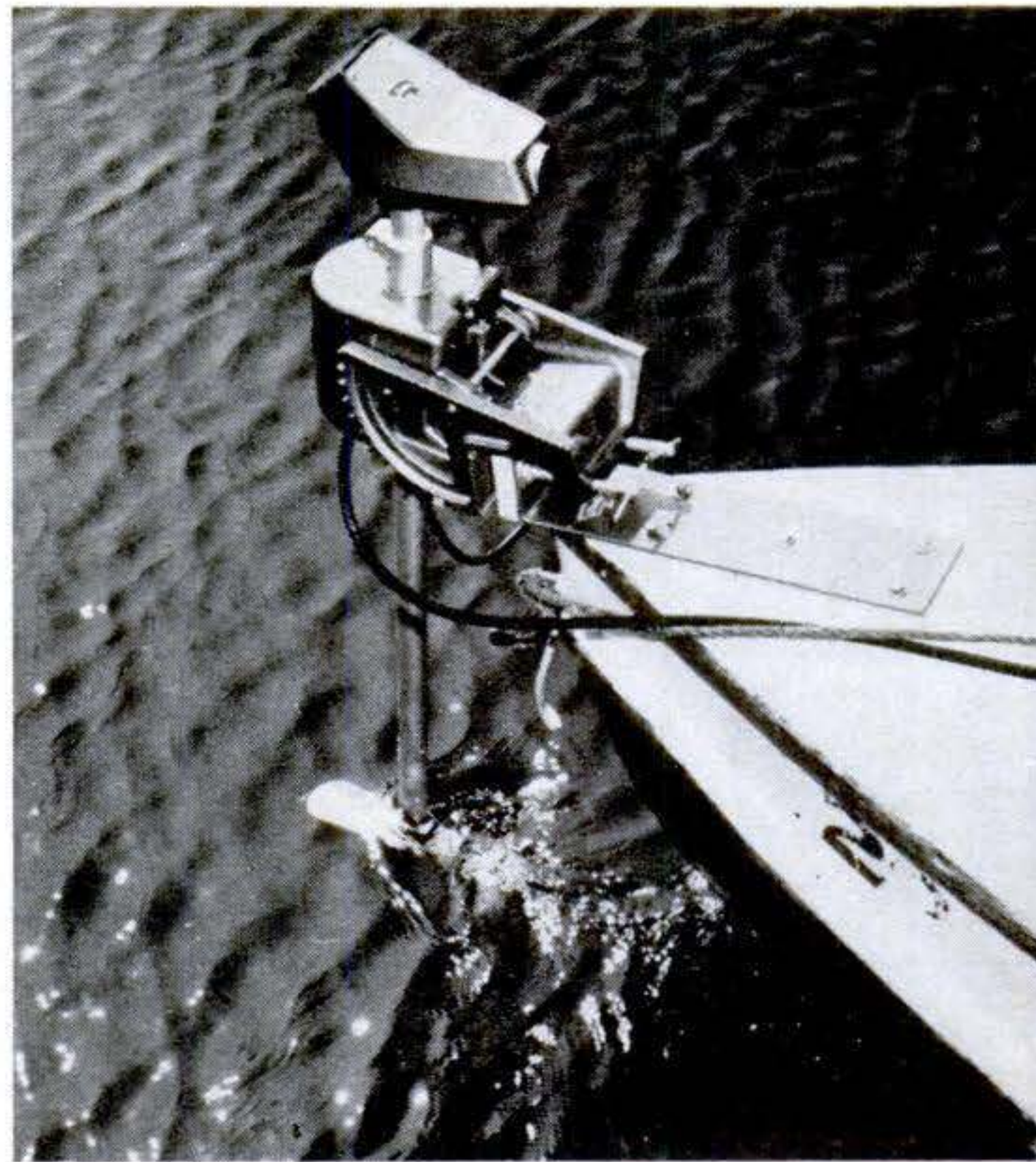
Dunk 'em or ride 'em high. Why are some electrics designed with the motor on top, others with it underwater? Motors on top keep the underwater profile slim, with only prop and steering fin to hang up weeds and lines. Time was, too, when it was worth something to avoid water-seal problems resulting from knocks that any motor takes; but new designs for motor housings and shaft seals handle that. A drawback in having the motor on top is that it usually takes transmission gears—a complication, though slight. A boost for underwater power units is the new, compact, permanent-



Bow-mount bracket puts the motor where you get fullest use of remote controls. This powerful Minn-Kota motor rides on arm that adapts to boat.

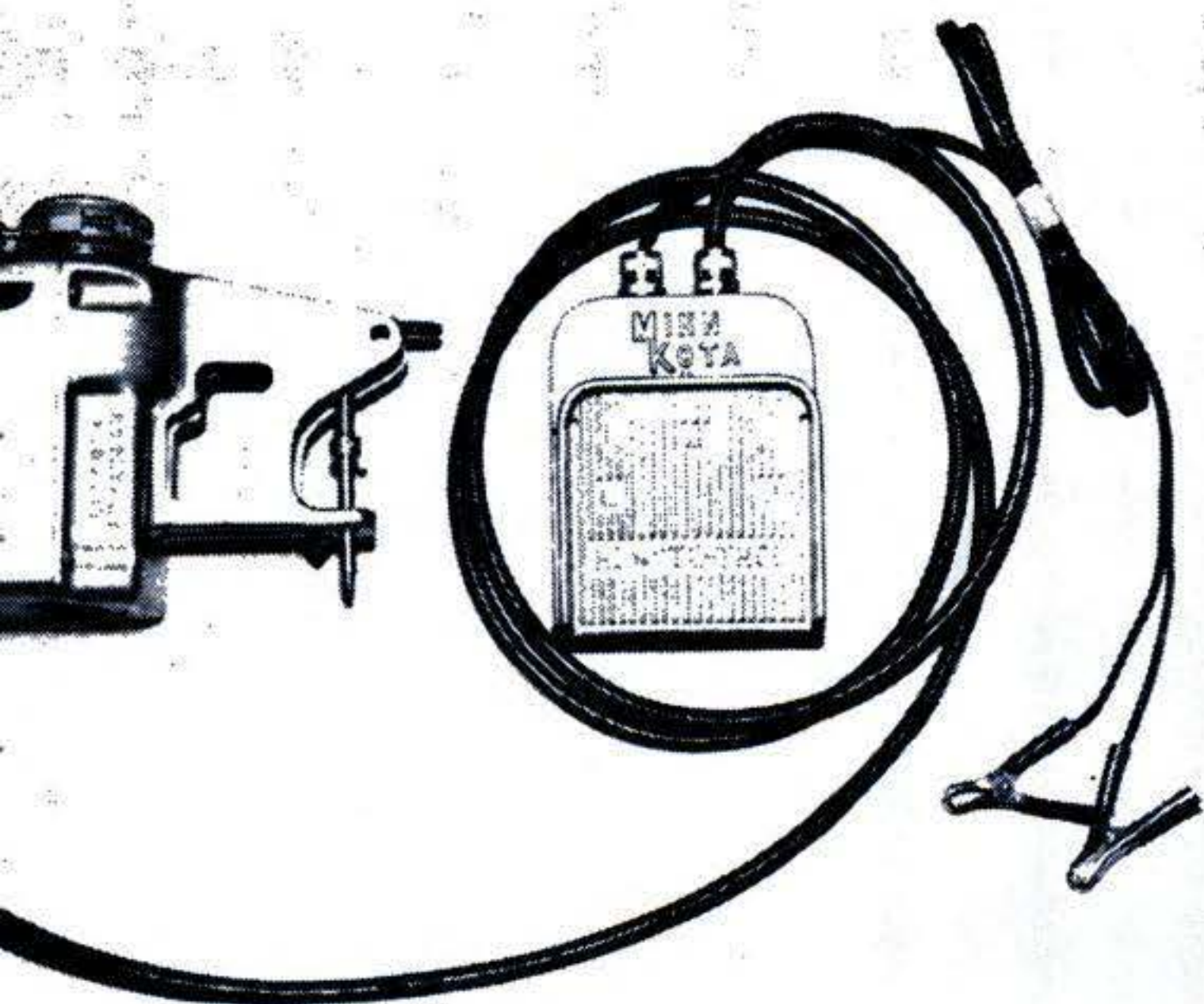
magnet motor. And with motor underwater, you have only the control head at the gunwales to get in the way of action.

A third design, using a flexible-cable drive shaft, combines a small underwa-



For boats with covered decks: Electra Pal's 12-position clamp attaches to permanent bow mounting. The right electric will serve boats as big as 18 feet.

-without actions that spook the game



Remote controls are powered by a small motor in unit attached to shaft, with a slip-clutch drive. The Minn-Kota remote, here, fits any shaft size.

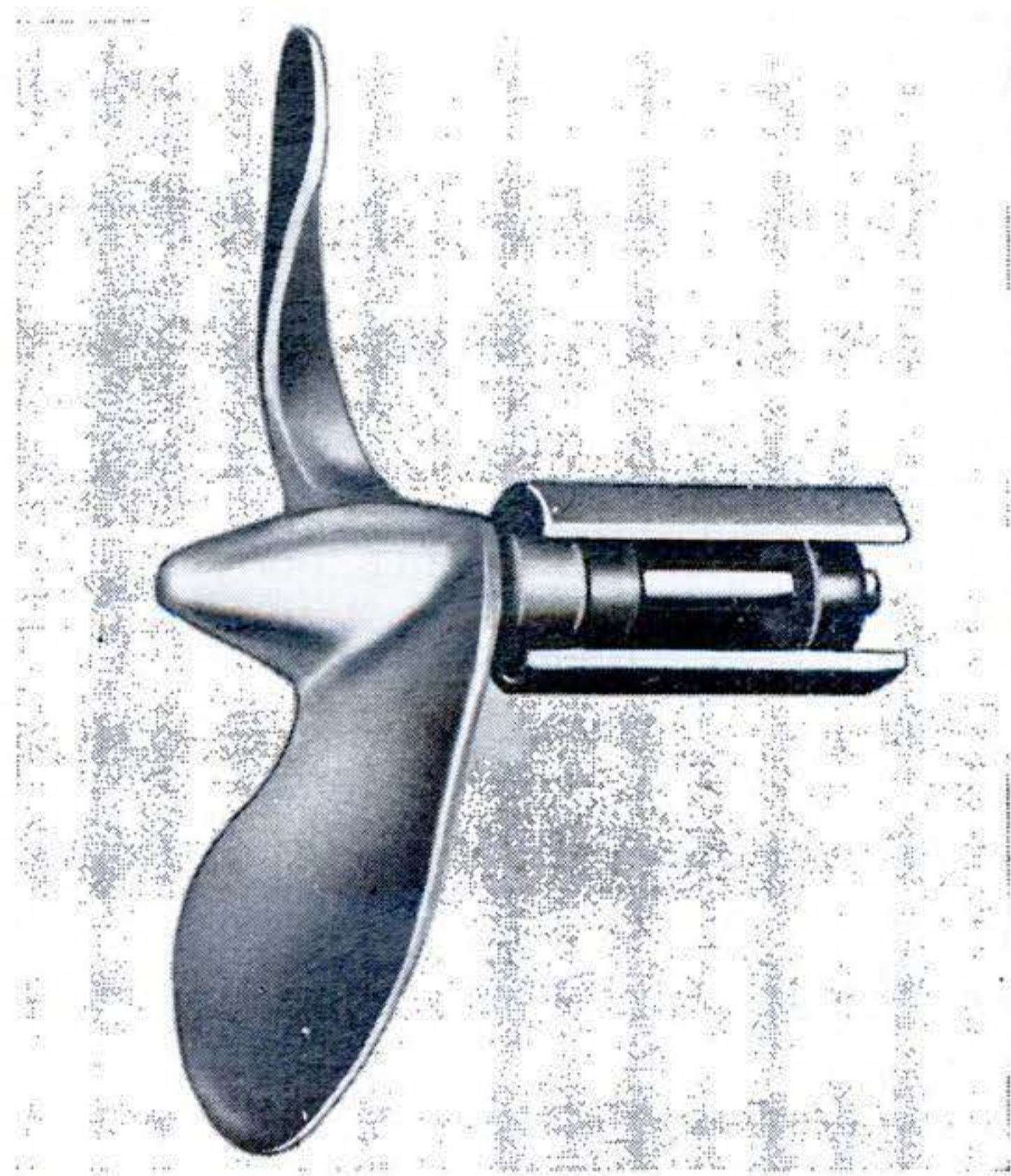
ter profile with direct drive. Minn-Kota's famous CDR has been built this way for 35 years! Electra Pal's Pike now has it, too. Chief Engineer R. E. Hedstrom of Electra Pal says the only problem in



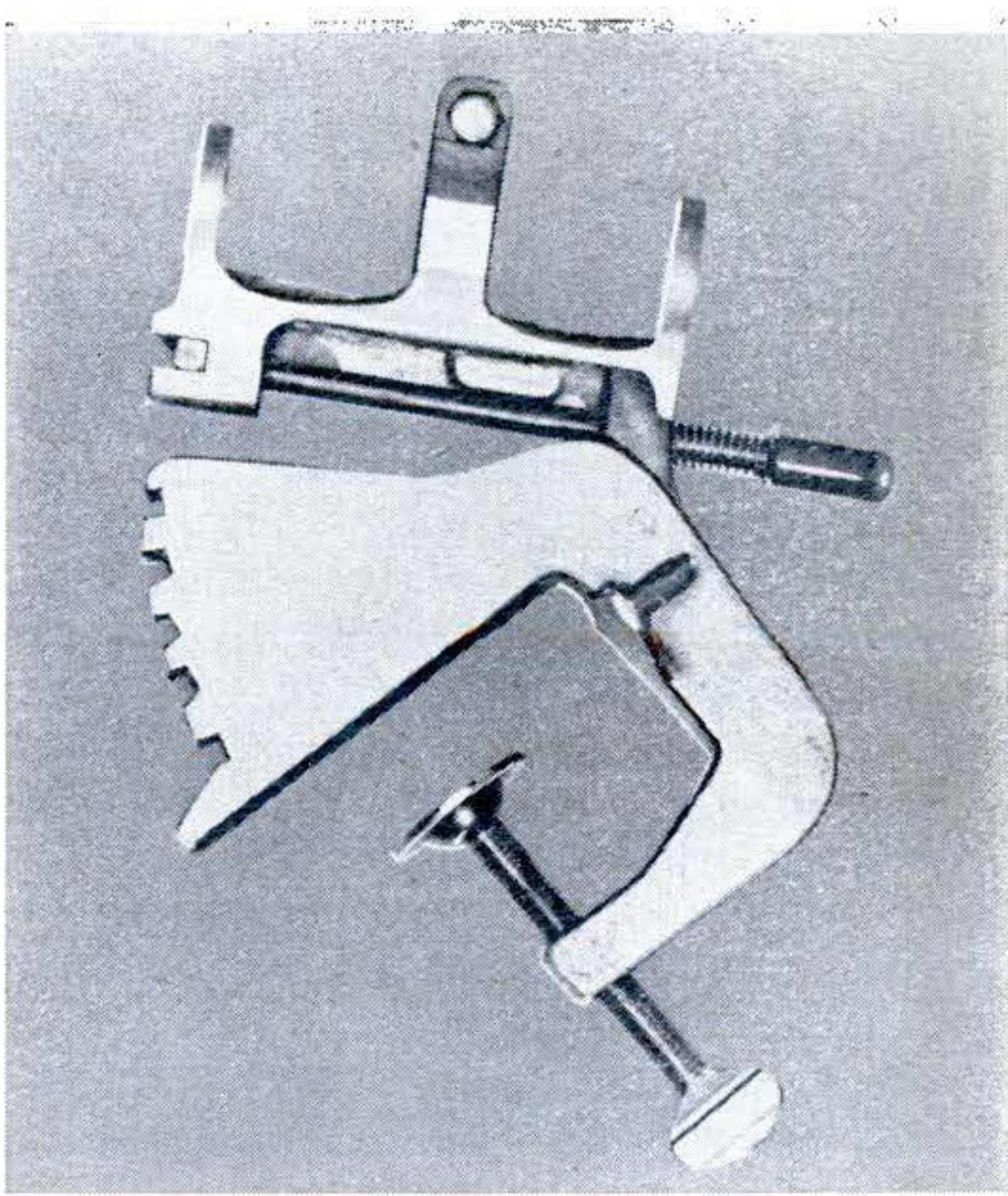
Permanent-magnet motors on Shakespeare Wondertrolls save juice, let you fish more than a day on one charge. The 101, right, weighs six pounds.

this design is that the cable shaft may whip against the sleeve at top r.p.m. For this reason, the stainless-steel cable has to be set to exact length.

[Continued on page 206]



How do motors stay dry in underwater location? Ingenious waterproof shaft-bearing seals do the trick. These illustrations show Shakespeare details.



Motor bracket that fits anywhere on boat's gunwales is a practical feature most owners want. Hardware should be stiff enough to hold position you set.

Just for Fun...Take

Car, boat, or plane—there's plenty of room to stow away one of these new little two-wheelers with the gutsy engines and small price tags

By JIM DAVIS



Nothing beats a minibike for really compact personal transportation. Like this Harrison Wildcat, many have folding handlebars for easier storage, an automatic clutch for simpler driving.

The big news in minibikes, if you haven't already noticed, is the way sportsmen are adopting them. Fliers slip them into the luggage compartment; hunters and fishermen, into the car trunk; campers, onto trailer tongues or bumpers; and boaters, under the foredeck.

Outdoorsmen have discovered that the little vehicles can carry big people, too, and they like their portability, sturdy engines, and modest price tags. Many sell for under \$150, which makes them more of an accessory than a major purchase.

Minibikes aren't all the same. So if you're planning to add one to your outdoor equipment, here are a few things to ask yourself before going out to buy:

- How will I use it most often?
- How will I carry it?
- How much riding will I do?

When you've answered these questions you'll be able to figure out what features to look for and roughly how much your minibike should cost.

First consider use. For a private pilot who will merely scoot across an airport apron occasionally, the starkest bike avail-

able makes sense. No need for a suspension, fancy fenders, or headlight. Save weight and money—small size is what you want.

A backwoods trail rider who goes on long trips and gets out frequently on weekends will find more elaborate models worth the additional cost. If that's your plan, you won't like the jarring ride of an unsprung minibike over uneven ground; not for long. A suspension and good brakes are important. You may want more horsepower, perhaps a multispeed transmission, and folding footrests.

These are the two extremes. You'll have to decide which comes closer to your probable use.

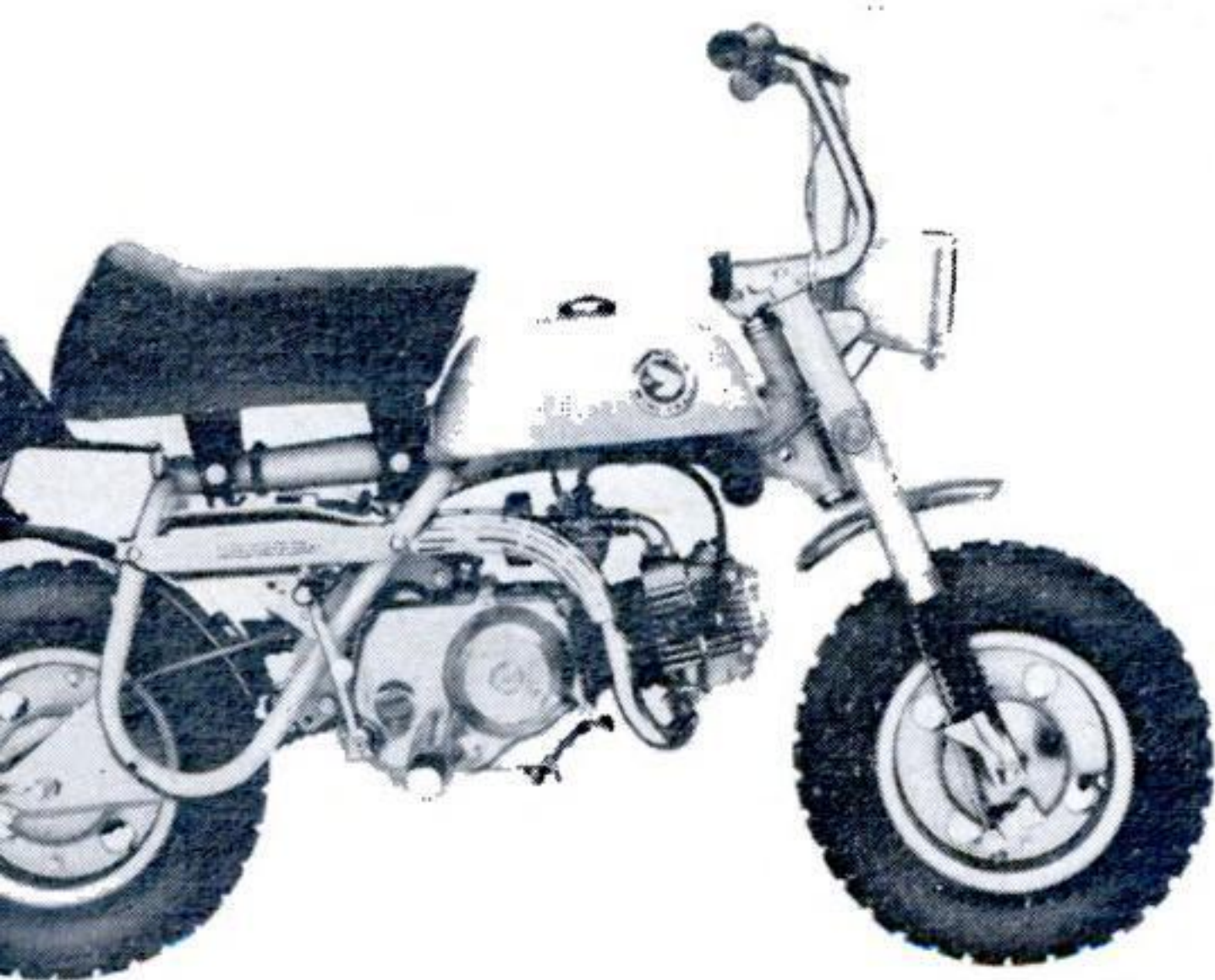
Carrying a minibike. Having made much of their small size, let me warn you about appearances. A bike that looks compact on the dealer's floor may not fit upright in the back of your station wagon, for example. Usually the handlebars stick up too high, occasionally the wheelbase is too long. Try loading the bike before you clinch the deal, if you can. Or at least take a tape measure along to see if

MINIBIKE Along



Bolt-on ski, an extra available for some machines, adds winter versatility to Heathkit's Boonie Bike. Minibikes are handy sportsmens' range-extender.

Easy-to-assemble kits give you more minibike for the money. Deluxe Michrina 5000 KX kit, above, includes front and rear suspension, chromed parts for \$210.



Miniature motorcycles as sophisticated as their big brothers share the minibike label. This Honda Mini-Trail meets the licensing rules of many states.

Minibike range has extended upward to include more models like this Bonanza with suspension front and rear, full-sized exhaust pipe, headlight.

the minibike will fit the opening and cargo space you have. If it's a tight fit you may even want a machine with folding handlebars.

Weight can be important, too. Some bikes weigh as little as 65 pounds, while others top 150. Unless you're built like

King Kong, you'll have trouble wrestling a heavy one around by yourself.

Those little engines. Except for the miniature motorcycles and a few minibikes with motorcycle engines, all of the little two-wheelers are powered by indus-

Continued

MINIBIKE SPECS		ENGINE MAKE	2-OR 4-CY	DISPLACEMENT (cc)	HORSEPOWER	BRAKES		SUSPENSION		WEIGHT	PRICE
MAKE	MODEL					FRONT	REAR	FRONT	REAR		
BEEHOO	Amphi-Kitty	B & S*	4	—	5	no	hand	no	no	135	—
BENELLI	Buzzer	Benelli	2	—	—	hand	hand	yes	no	68	\$21
	Hornet	Benelli	2	—	—	hand	hand	yes	no	90	25
	Dynamo Compact	Benelli	2	50	—	hand	foot	yes	yes	98	31
BIRD	Wren	Tecumseh	4	120	2.5	no	foot	no	no	77	12
	Lark	Tecumseh	4	148	3.5	no	foot	no	no	66	13
	Duck kit	Tecumseh	4	148	3.5	no	foot	no	yes	80	15
BONANZA	BC-1000	—	4	127	2.5	no	foot	no	no	95	—
	BC-1100	—	4	127	3	no	hand	yes	no	90	—
	BC-1200	—	4	148	3.5	no	hand	yes	yes	110	—
	BC-1300	—	4	172	4	no	hand	yes	yes	115	—
	BC-1400T	—	4	200	5	opt.	hand	yes	yes	125	—
	BC-1500SH	Hodaka	2	100	10	opt.	hand	yes	yes	125	—
BONHAM	Mini-Gote	B & S	4	—	5	no	hand	yes	yes	115	—
	Tote Gote 531	B & S	4	—	5	no	hand	yes	yes	140	—
	Tote Gote 750	B & S	4	—	7	hand	hand	yes	yes	200	—
	Tote Gote 650	B & S	4	—	7	hand	hand	yes	yes	165	—
	Tote Gote 770	B & S	4	—	7	hand	hand	yes	yes	200	—
	Tote Gote 780	B & S	4	—	7	hand	hand	yes	yes	160	—
CAL JET	ElectraMite	Electric	—	—	—	no	foot**	no	no	50	14
CENTRAL	Charger Jr.	Tecumseh	4	—	3	no	foot**	no	no	—	14
	Charger 3	Tecumseh	4	—	3	no	hand	no	no	85	16
	Charger 2	Tecumseh	4	—	3	no	hand	no	yes	85	18
	Charger 1	Tecumseh	4	—	3	no	hand	yes	yes	85	21
CHEYENNE	100	Tecumseh	4	127	3	no	hand	no	no	62	—
	200	Tecumseh	4	127	3	no	hand	no	no	68	—
	300	Tecumseh	4	148	3.5	no	hand	yes	no	71	—
	400	Tecumseh	4	148	3.5	no	hand	yes	yes	82	—
CLYMER	Indian Ponybike	—	2	—	5	hand	foot	yes	yes	—	29
COUPARRAL	Tony-Pony	McCulloch	2	134	10	no	hand	yes	yes	100	—
DRAKE	Mickey-Bike	B & S	4	—	3	no	no	yes	no	—	16
ENGINE SPECIALTIES	Broncco TX-3	Tecumseh	4	—	2.8	no	foot	no	no	75	17
	Broncco TX-2	Tecumseh	4	—	2.8	no	hand	yes	no	85	19
	Broncco T/C4	Garelli	2	—	5	hand	foot	yes	yes	105	29
	Broncco T/S4	Garelli	2	—	5	hand	foot	yes	yes	120	31
FOX	Marauder	Lauson	4	—	4	hand	foot	yes	yes	95	—
	Campus	Lauson	4	—	4	hand	hand	yes	yes	95	—
	Spoiler	Lauson	4	172	—	no	yes	yes	yes	101	—
G.E.M.	Go Devil	Fuji	2	53	—	no	hand	yes	yes	69	23
HARRISON	Wildcat	B & S	4	—	5	no	hand	no	no	105	—

*Briggs & Stratton **Bar or shoe presses on tire. ††Band around drum alongside rear wheel.

trial units. They run their hearts out if given considerate treatment. But cutting the grass once a week can't compare with lugging a 175-pound man up hill and down dale for hours at a time. So if you expect to use your minibike a lot, consider the engine carefully.

Having answered the three questions and glanced at the chart, you probably have a fair idea what type of machine to look for. Before you go shopping, though, let's face up to an important fact: These little fellows can be risky to ride on busy roads.

Some minibikes are all rigged up for street riding and can even be licensed. But driving in traffic knee-high to a hubcap, with little tires that fall into potholes and don't corner very well, straining to keep up, can hardly be considered sensible. If you're looking for a low-cost motorcycle, forget a minibike. But off-road riding has its own special charm. Why risk your neck riding the highway on something

that was never designed to go there?

Shopping tips. Usually, with most vehicles, your choice of brands is restricted by the proximity of dealers. But you can buy some minibikes in kit form, direct from the manufacturer or distributor. And even if you drive far afield to get a particular model, most have standard-brand engines that can be serviced locally.

Comparing minibikes. When you really start shopping, here are some points to watch for:

Seating position. Sit on the bike with a foot on the rest. If your knee bends much more than 90 degrees you'll soon feel cramped.

Brakes. Most minibikes now have an internal expanding brake on the rear wheel; few except the miniature motorcycles have them on the front wheel. It's always safer to have two brakes; whether you need a front brake, too, depends on the bike's horsepower and how you use it.

[Continued on page 224]

MINIBIKE SPECS		ENGINE MAKE	2- OR 4-CYC	DISPLACEMENT (cc)	HORSEPOWER	BRAKES		SUSPENSION		WEIGHT	PRICE
MAKE	MODEL					FRONT	REAR	FRONT	REAR		
HEATHKIT	Boonie Bike kit	B & S	4	—	5	no	hand	yes	no	116	\$190
HONDA	Mini-Trail Trail 70	Honda	4	50	2	hand	hand	yes	yes	108	240
		Honda	4	72	—	hand	foot	yes	yes	108	—
ITAL JET	Kitkat	Gyromat	2	50	2.5	hand	hand	no	no	73	240
JAN/HO	Zebra	—	2	49	4.5	hand	hand	yes	no	85	240
KAWASAKI	Coyote	Kawasaki	2	50	—	hand	hand	yes	no	75	160
KEYSTONE	Hi-Torque	—	2	50	3	no	hand	yes	no	85	180
KING O'LAWN	KB-2	B & S	4	—	2	no	foot**	no	no	—	130
	KB-3	B & S	4	—	2	no	foot**	yes	no	—	170
	Aggie Bike	B & S	4	—	5	no	yes	yes	yes	—	230
MAJOR	Cougar	Tecumseh	4	—	4	no	yes	yes	no	78	179
MICHIRINA	400	B & S	4	—	2.3	no	yes	yes	no	65	140
	450	B & S	4	125	3	no	yes	yes	no	65	150
	500	B & S	4	125	3	no	yes	yes	no	65	160
	600	B & S	4	125	3	no	hand	yes	no	75	190
	700	B & S	4	165	5	no	hand	yes	no	75	190
	4500	B & S	4	125	3	no	hand	yes	no	75	180
	5000	B & S	4	165	5	no	hand	yes	yes	99	230
	6000	B & S	4	165	5	no	hand	yes	yes	104	250
	7000	B & S	4	165	5	hand	hand	yes	yes	110	—
MYERS	Lynx Cub	B & S	4	—	3	no	foot**	yes	no	74	150
	Lynx 53	B & S	4	—	3	no	yes	yes	yes	80	190
	Lynx 63	B & S	4	—	3	no	yes	yes	yes	85	207
	Lynx 65	B & S	4	—	5	no	yes	yes	yes	85	222
NOVA	R-S	—	4	—	—	no	no	yes	no	70	130
	D-S	—	4	—	—	no	no	yes	no	70	145
POWELL	C	B & S	4	—	5	no	foot	yes	yes	110	200
SENSATION	Mike Bike	B & S	4	—	3	no	foot**	yes	no	78	160
SIMPLEX	MB-1	Lauson	4	—	2.5	hand	hand	yes	yes	—	—
	MB-2	Lauson	4	—	4	hand	hand	yes	yes	—	—
SKAT-KITTY	—	Tecumseh	4	124	2.5	no	foot	no	no	78	259
STEENS	Taco 22	B & S	4	125	3	no	foot**	yes	no	74	140
	Taco 44	B & S	4	125	3	no	hand	yes	yes	—	170
	Taco 99	B & S	4	200	5	no	hand	yes	yes	85	190
	Frijole kit	B & S	4	127	3	no	hand	no	no	65	120
	Taco 100	B & S	4	200	5	no	hand	yes	yes	93	220
TRAIL HORSE	GTO 100	Tecumseh	4	110	2.5	no	hand††	no	no	83	—
	GTO 800	Tecumseh	4	155	3.5	no	hand††	yes	no	94	—
	GTO 1500	Tecumseh	4	220	5	no	hand††	yes	yes	132	—



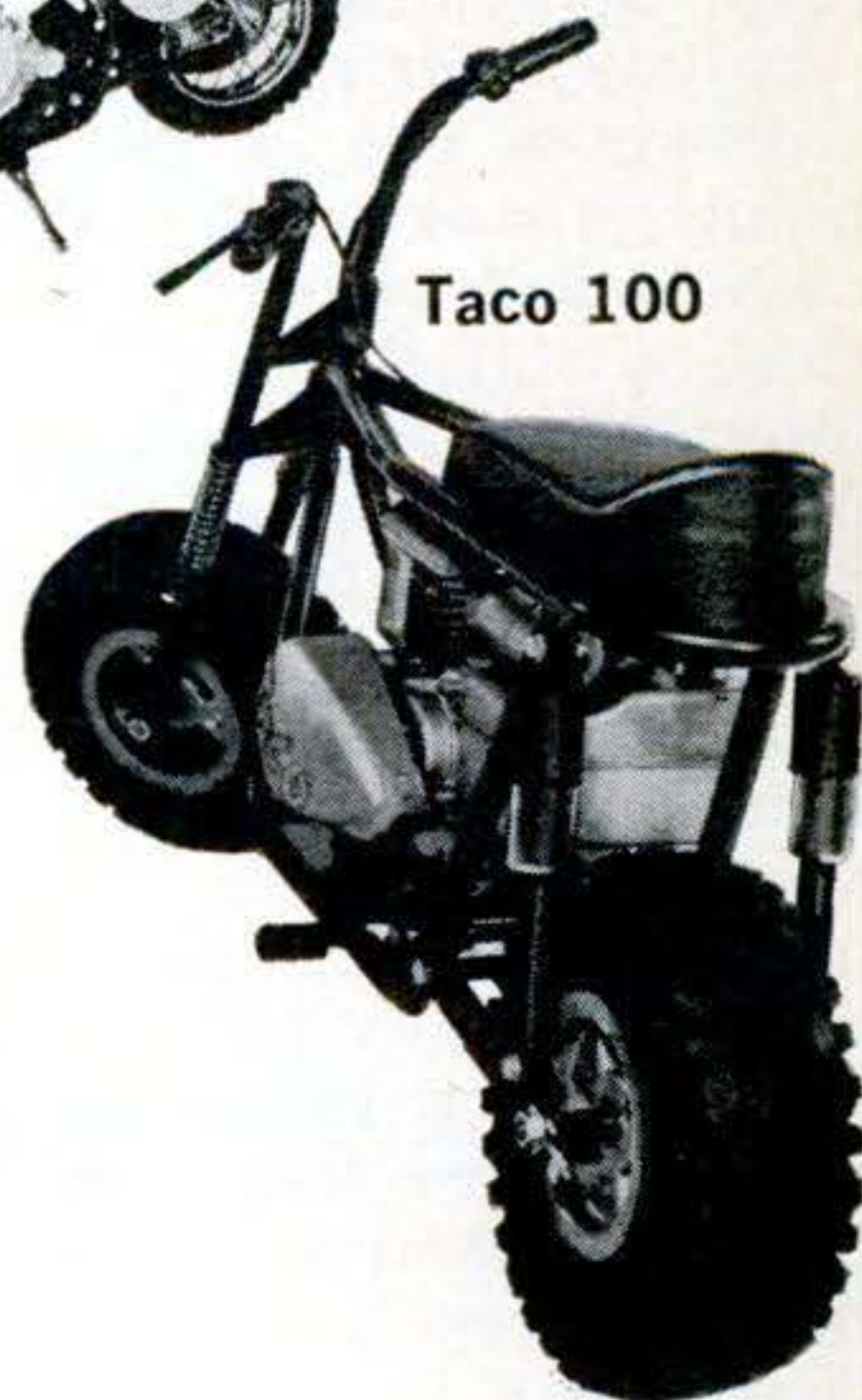
Charger 1



Fox Spoiler



Rupp Roadster



Taco 100



"Lil" Indian 600



Tote Gote 770



Coming out of a deep bog, the Trail Boss gets lots of go from its 20-hp. Kohler two-cycle engine.



Down a 45-degree grade comes the ATV, under safe control. It scrambled to top after several misses.

PERSONAL-USE REPORT

New ATV: 20 Horses

By E. F. LINDSLEY

PS Outdoor Power Equipment Editor

All-terrain vehicles, or ATVs, tend to be highly individualized, and the Sierra Trail Boss by Vesely, makers of Apache camping trailers, is no exception. Power, drive train, and handling are distinctly individual. But, as with any ATV, you have to drive it to know it.

Power is one of the Trail Boss's big points. Other machines have 20 hp. or more, but few are in this weight class. Here, a full 20-hp. Kohler two-cycle is directly connected to move less than 700 pounds of machine. The specs promise 35 m.p.h., and for wide-open spaces, it's a ground burner.

The same power produces some awesome hill-climbing abilities. Back off and take a run at a hill, and the spectacular up-and-over performance can leave you in orbit. Frankly, it left me in near panic watching Ted Roess of Vesely go up a plus-50-degree test bank that only one other ATV had made before. The power to take steep hills, of course, can be a deadly trap if your ATV can't stay up-

right on the day you hit the hill you don't make. To the Trail Boss's credit, it slid around sideways and came back down several times, plowing and slithering, but with no tendency to roll.

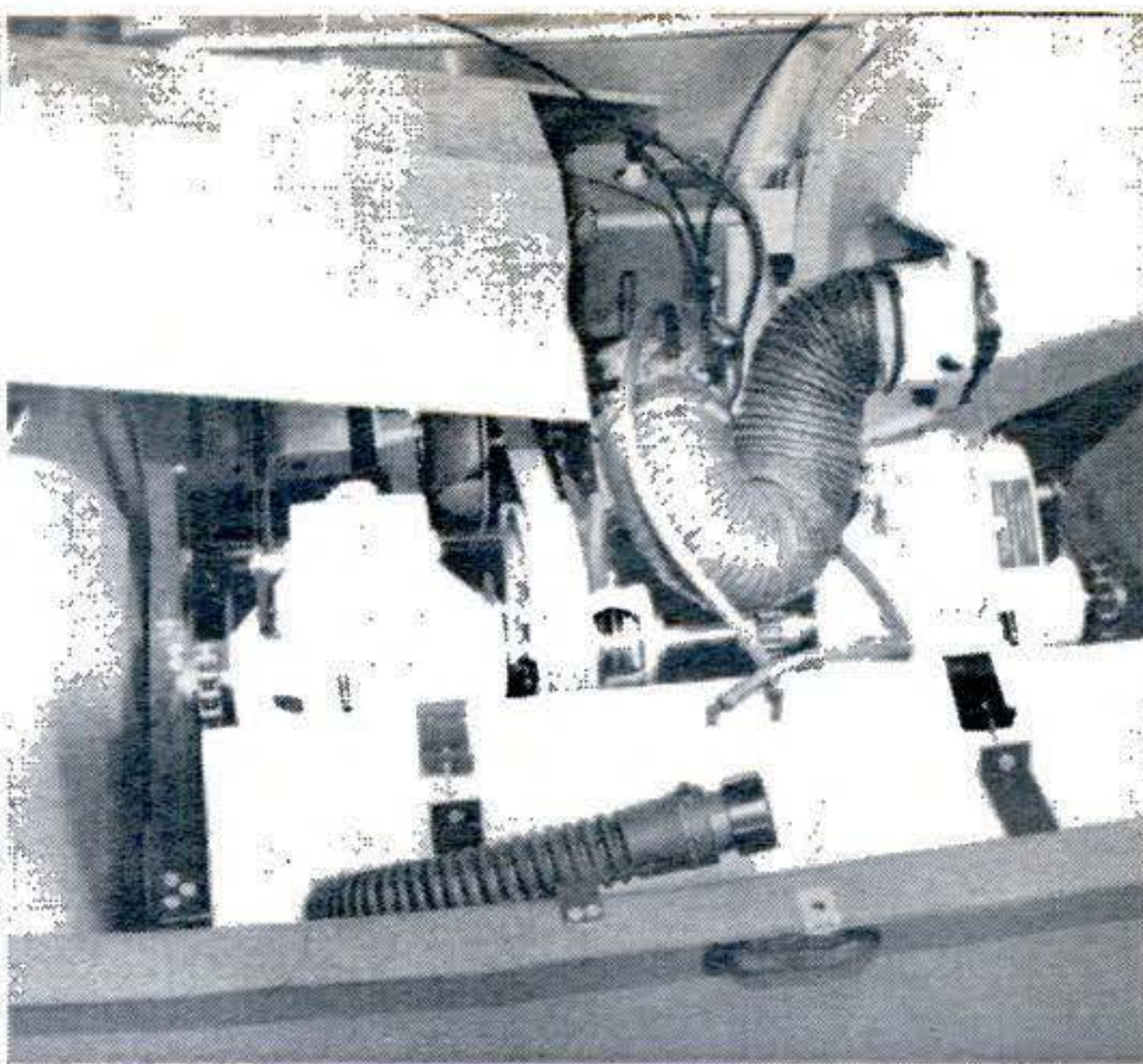
So much for scat and go. What's under the tough polyethylene skin? It's easy to find out. The entire top—seats, rear deck, and all—lifts off. Anyone who has ever stood on his head to replace a cotter pin hidden up under a deck will appreciate this feature. Not that there aren't tight spots in the Trail Boss. I found a few in replacing one of the No. 50 roller-chain links, but I'm ready to believe the claim that the entire engine can be freed and lifted out in 12 minutes.

With the deck off, some interesting parts are apparent:

- A massive channel-steel (12-gauge) chassis riveted together.
- Rigid, positive bar linkages to the steering clutches.
- Two very husky planetary gear and clutch boxes.
- A multi-ratio Salisbury converter drive.
- Two metal chutes for cooling and carburetor air intake.



Floating high, the Trail Boss makes fair headway in water—even though it's not intended to be a boat.



V belt (center of photo) and Salisbury multi-ratio drive provide input to gearboxes on each side.

for the Trail

The drive train and steering are unique. Each gearbox is linked by a rigid bar to a steering lever in the cockpit, and is thus individually controlled for forward or reverse. Center the control sticks and you're in neutral; push forward and you go forward; pull back and the Trail Boss backs up. Move the controls singly and each side moves according to command, and you steer. For downhill braking, just pull back on the sticks and rev the engine.

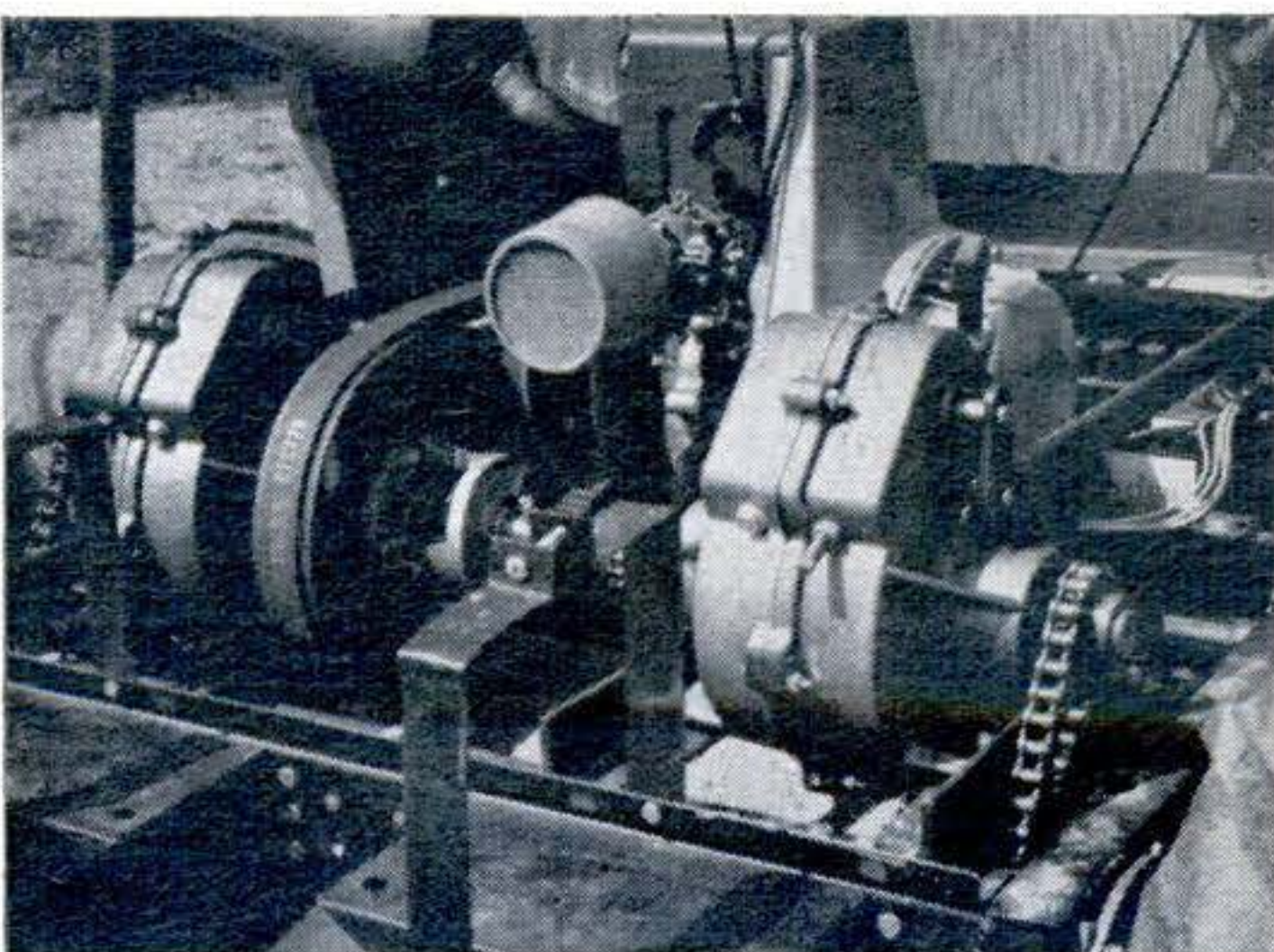
Starting and lighting are conventional from a 12-volt battery. On occasion, however, like most two-cycles, starting seemed temperamental. The Kohler engine burns a gas/oil mix—but, advises Vesely, buy an oil made for air-cooled two-cycle engines, not outboard oil!

We tried the Trail Boss through brush and bracken and watched it work on hills and bog. It did its job well. Bog and water performance are about average—reliable, but slow and wallowing.

If we were looking for a fast ATV with lots of hill ability, a smooth ride, two-person seating with a hopper aft to carry gear, and rugged construction, we'd look hard at Vesely's Sierra Trail Boss. The \$1,495 price is right, too.



Deck and seats lift off for total access to innards. Demountable wheels are great service feature.



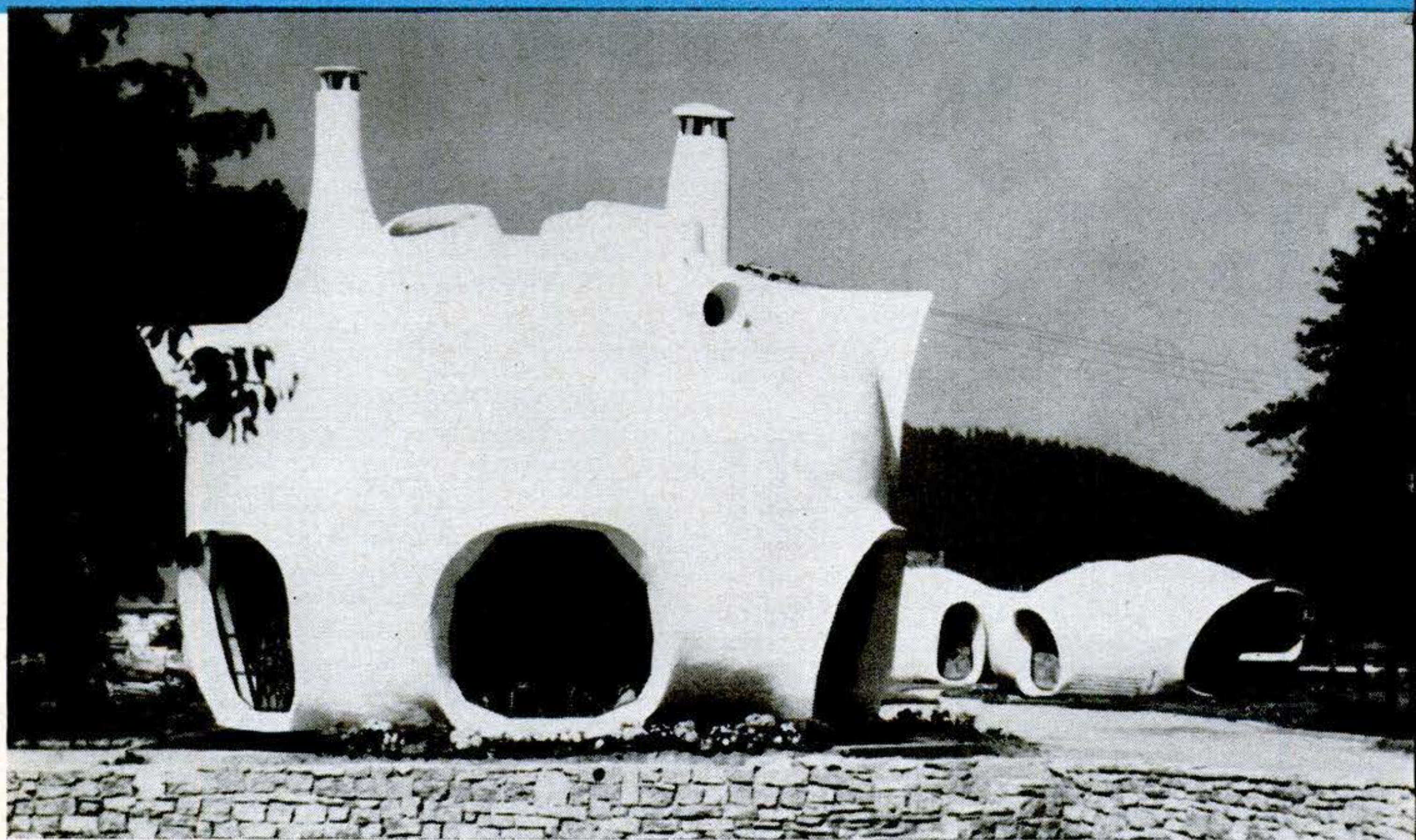
Sturdy frame and roller-chain final drive can be seen here. Crank arm on the side of the gearbox (right) is linked to control lever at front.

SPECIFICATIONS

Body: high-density polyethylene; **frame:** 12-ga. steel channel, riveted; **engine:** Kohler 20-hp. 309cc, 2-cycle single-cylinder, air-cooled; **drive:** all six wheels, $\pm$ 50 roller chain; **torque converter:** Salisbury 770; **transmission:** Vesely planetary/clutched steering; **amphibious drive:** lugged Super Terra Grip tires; **weight:** 665 lb.; **height:** 36"; **length:** 89"; **width:** 57"; **fuel capacity:** 7 gal.

What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

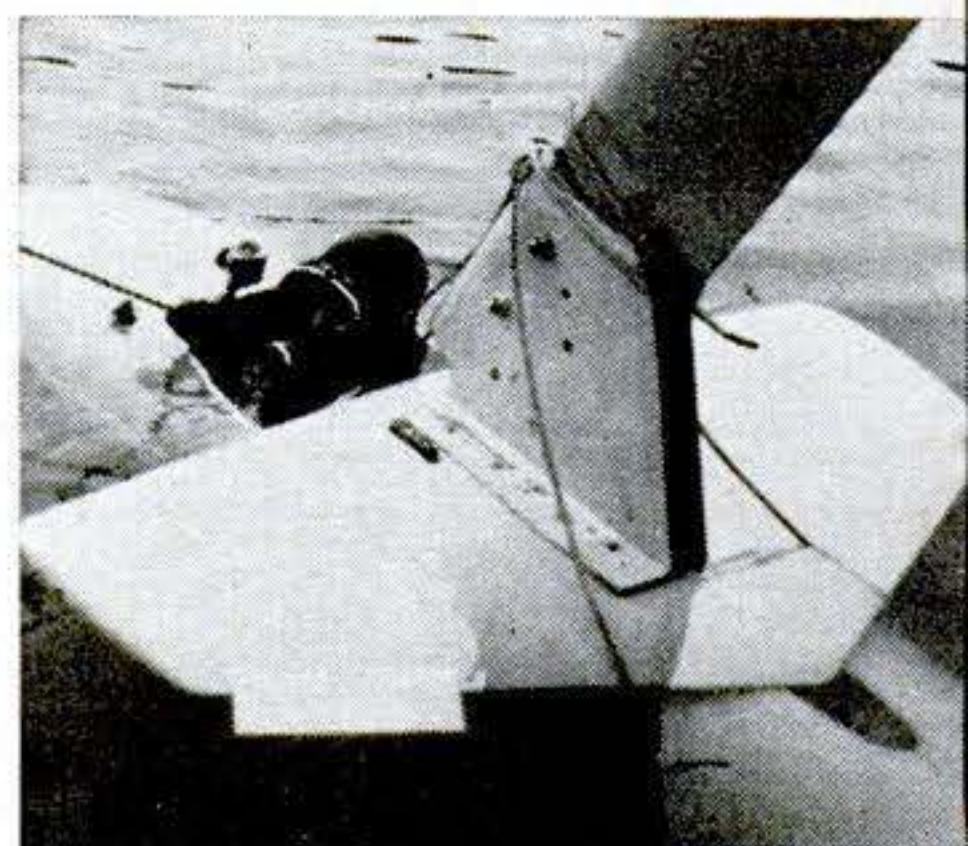


▲ Sleep in a seashell

Planning to visit the Alsace-Lorraine section of France? The town of Raon l'Etape offers the Motel de l'Eau Vive—nine units like these, scattered over a peninsula. Each is equipped with television and stocked refrigerator. The polyester-surfaced concrete shell cuts construction costs, owner says.

Man-carrying torpedo ➤

Skimming several feet below surface at 10 to 15 knots, this mini-sub escapes raging storms to speed divers to underwater worksites. Half-scale prototype tested by Braincon Corp. has an open one-man cockpit and pivoting snorkel mast for the diesel engine. On deep trips, battery powers it.



◀ Inflatable speedboat

At 50 m.p.h. it barely keeps the prop of its 125-hp. Mercury in the water. It's the new 14-ft. Delta, from world's largest manufacturer of inflatable boats—Metzeler AG of Munich. Aiming for chunk of the U.S. market, Metzeler claims high stability, safety, maneuverability—not to mention altitude.



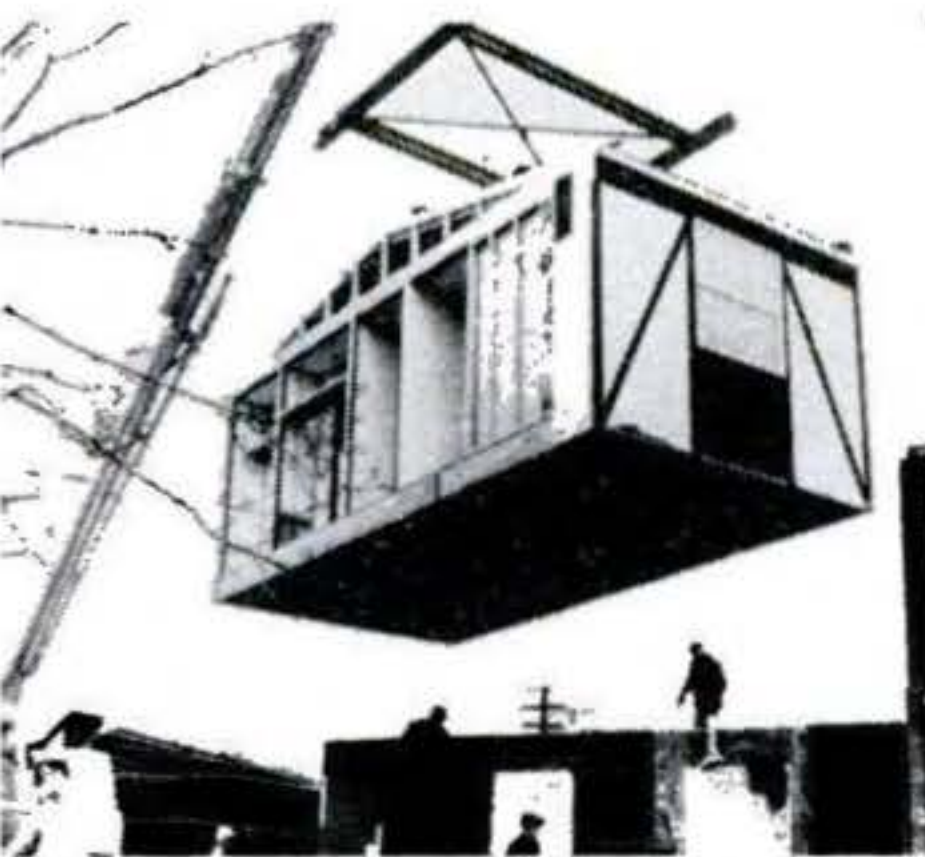
Disguised burglar alarm

As tiny as a grain of rice, an electronic emitter is tucked behind the lens in the dummy wall socket, left. It shoots an infrared beam at a receiver in another outlet up to 75 feet away. If intruder crosses beam, alarm sounds. Mini-Sentry works off six-volt battery. \$200 from Texas Instruments.



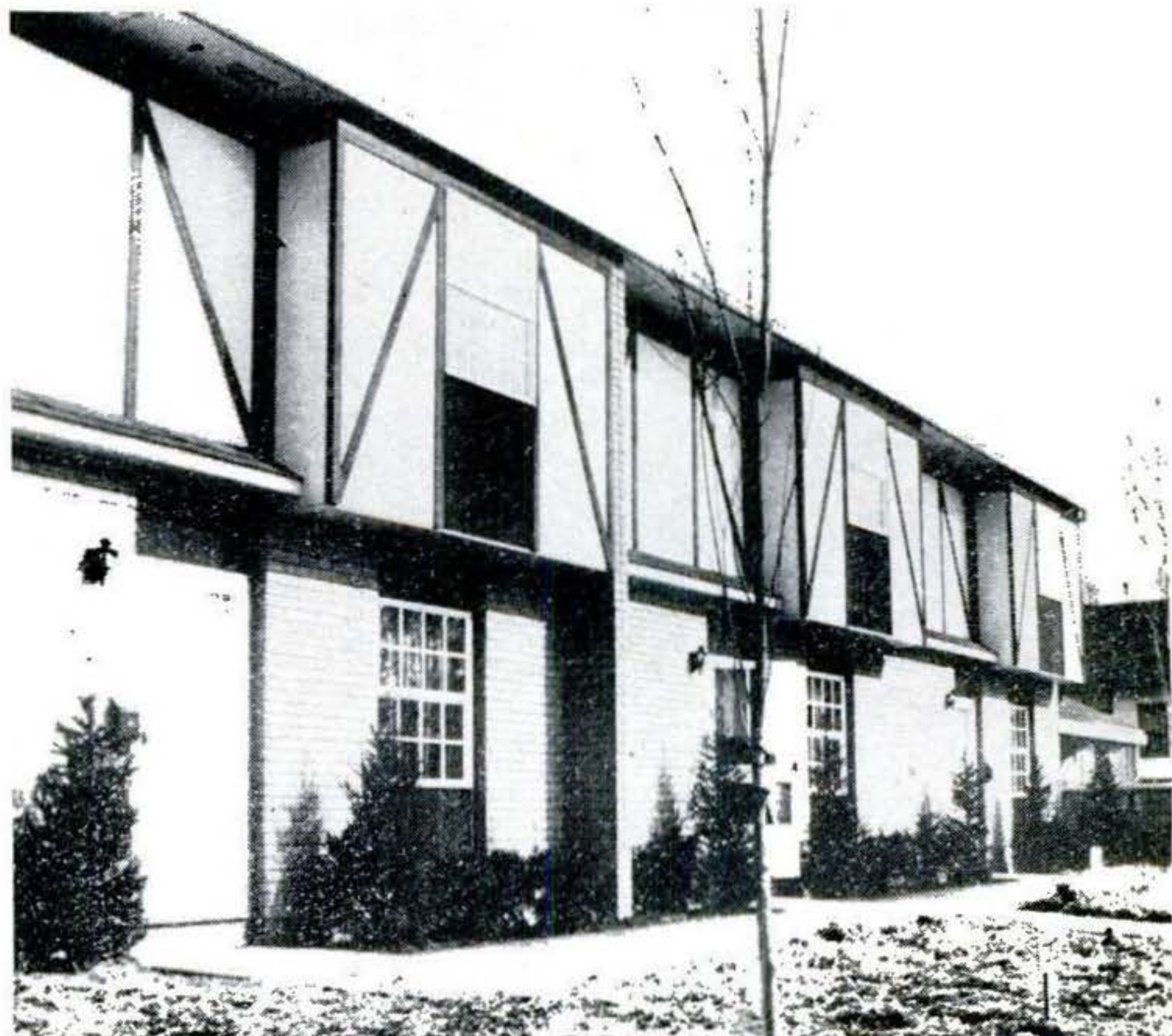
Two-speed baby cart

One-hand stroller converts in seconds to a safe car seat when faster transport is called for, saving transfer of a wriggling infant. Light, strong polystyrene shell is designed to strap into an adult seat belt, has its own shoulder straps. \$29.95 ppd. from Kiddie Kar-Go, No. Conway, N.H. 03860.



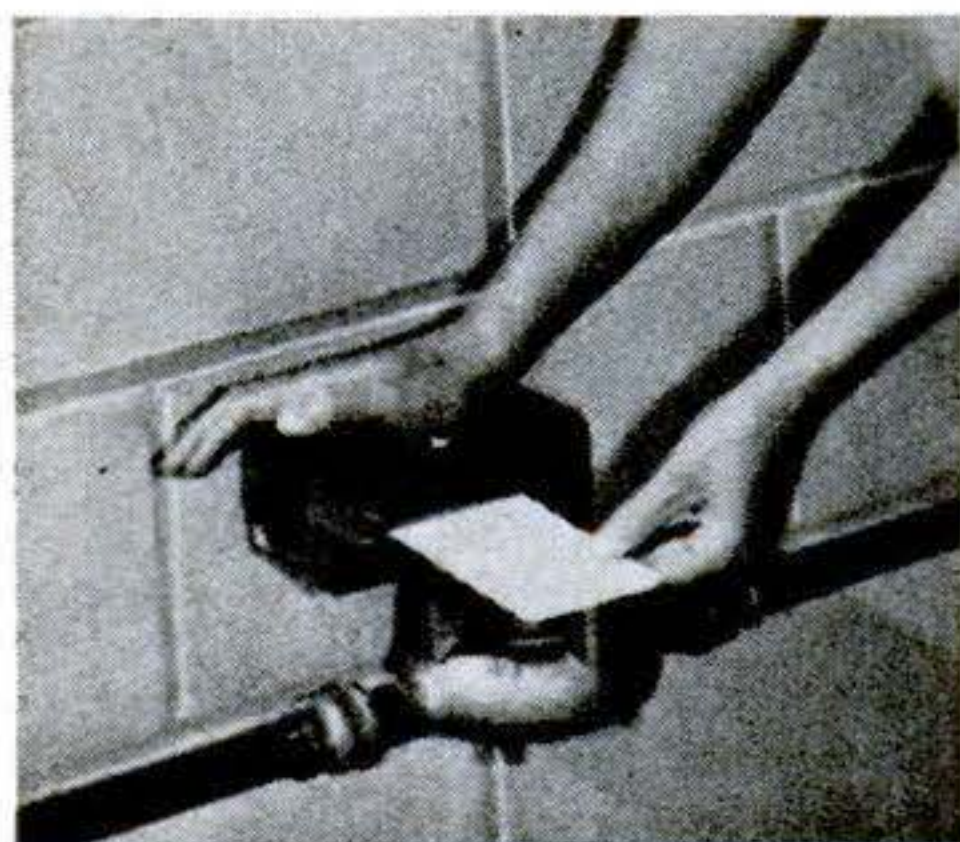
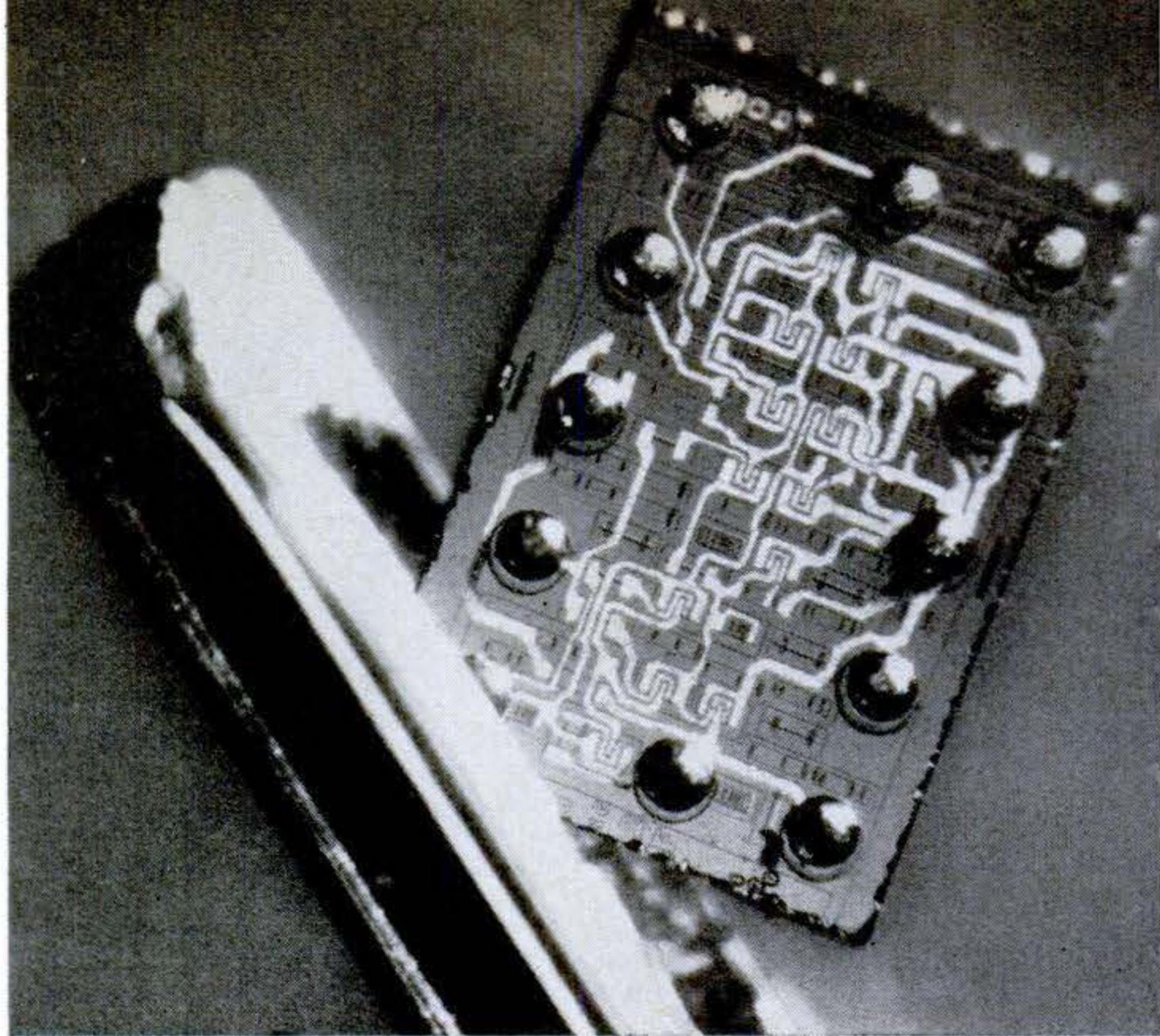
Instant town houses

A row of Tudor homes can be erected in hours by stacking factory modules made by Stirling Homex Corp. of Avon, N.Y. Each home consists of four units—two on ground, two on top by crane. Each module contains fully furnished rooms, ready for occupancy when plumbing and wiring are connected.



Needle's-eye brain ►

Logic circuit element of IBM's Monolithic Systems Technology is contained in a chip measuring 43 by 63 thousandths of an inch; it passes through a needle's eye as shown in magnified photo. MST provides System/3 computers with switching speeds of 8 to 12 billionths of a second.

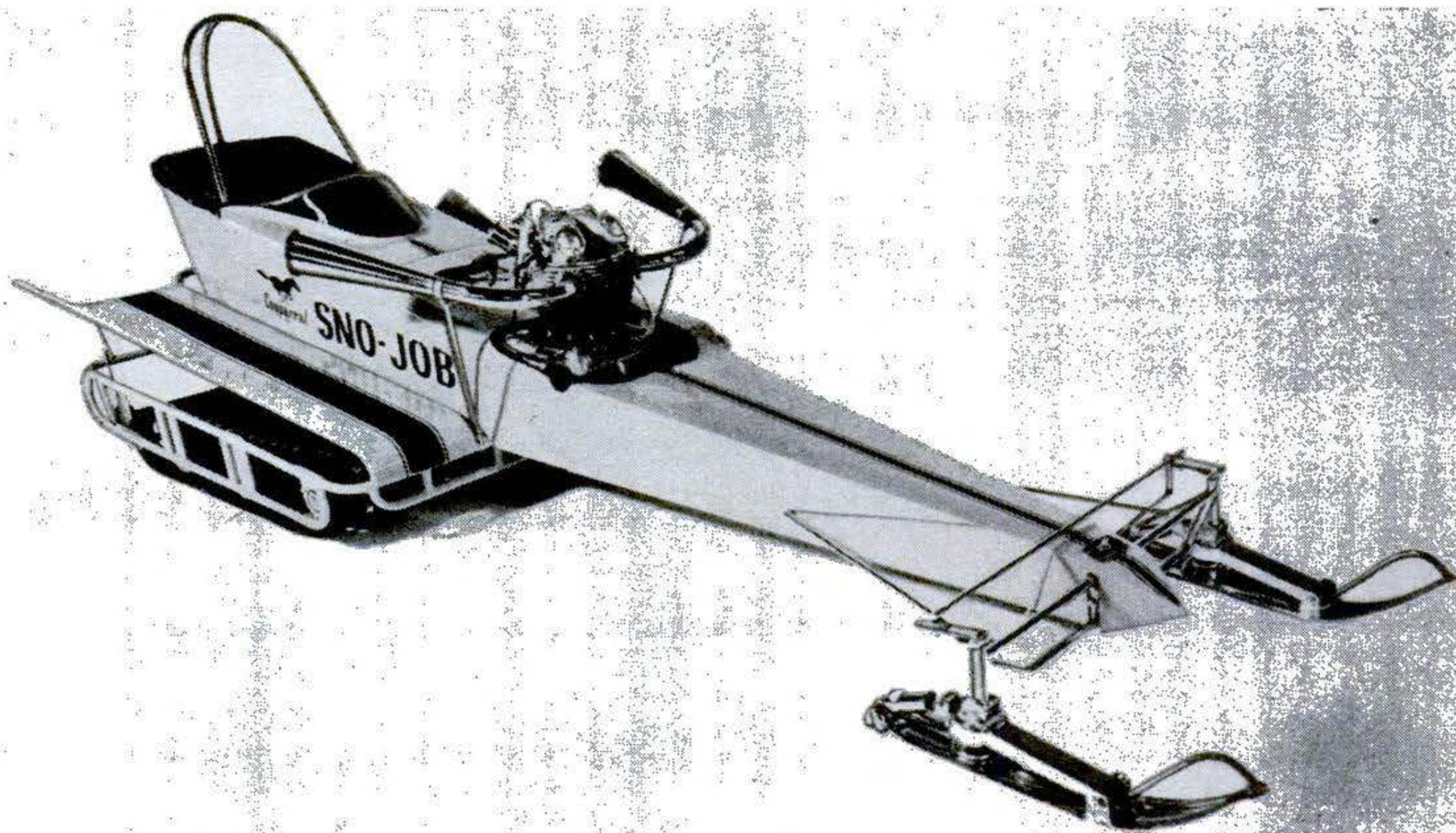


◀ Automated water bill

Give your water meter route man a nice gift—you may never see him again. Device from Metrix Data Systems of Rochester attaches in minutes to existing meters. You'll insert a tab card, push a button to punch it, and mail it to the water company; they'll put it right in their billing computer.

Snowmobile racer

Just in time for winter meets, Couparral Co. (1460 Sibley Hwy., St. Paul, Minn. 55118) announces a new snow-racing concept. Similar to a land dragster, Sno-Job is 12 feet long, weighs 440 pounds with 70-hp. Norton engine. Couparral hopes it will break 96-m.p.h. snowmobile record.





Copter dolly

One-man ground handling from hangar to fueling to takeoff is possible with the Manhandler Mark I platform made by Mainline Helicopters. Framed of structural steel with hardwood landing surface, the platform weighs for \$895, handles all skid- and float-equipped copters to 1,500 pounds.



Monster claw

Okay, everybody: First one to identify this seven-foot object before it eats the assembler gets 10 points. Wrong: It's Vought Aeronautics' 326-gallon fuel tank for an A-7 Corsair II. Rubberized cloth shape fits around the engine. The attack plane's biggest tank, it helps give the A-7 its unusual range.



Hybrid sportscar

Two leading German auto makers joined forces to produce this sporty new two-seater. The VW-Porsche 914, seen at Frankfurt's International Auto Show, can be ordered with 80-hp. Volkswagen engine for about \$3,000, or with Porsche's 110-hp. two-litre six for \$4,000.



Crash pillow

The cylinder in upper photo is Olin's Safe-T-Flate, an air-augmenting inflation system. Only a foot long by 1 3/4 inches in diameter, it inflates safety bag (bottom photo) instantly on an emergency signal, using a thimbleful of Ball Powder propellant to expand low-pressure air stored inside.



What's New



◀ Underwater television

The cylinder at far left is a watertight, remote-focus camera with a light source ringing the lens. It connects (via a cable 600 feet long) to closed-circuit controls beneath a midget TV. Battery-powered, it was developed by Radio-Electro of Geneva for—are you ready?—inspection of water mains.

Opulent Opel ▶

Good things come in this small package—a luxury experimental two-seater coupe. The Opel CD, based on the Diplomat Limousine with the wheelbase shortened to 100 inches, is just over 3½ feet high. For entry, the wraparound glass canopy and steering column lift forward hydraulically.

▼ Judy tucks in a tunnel

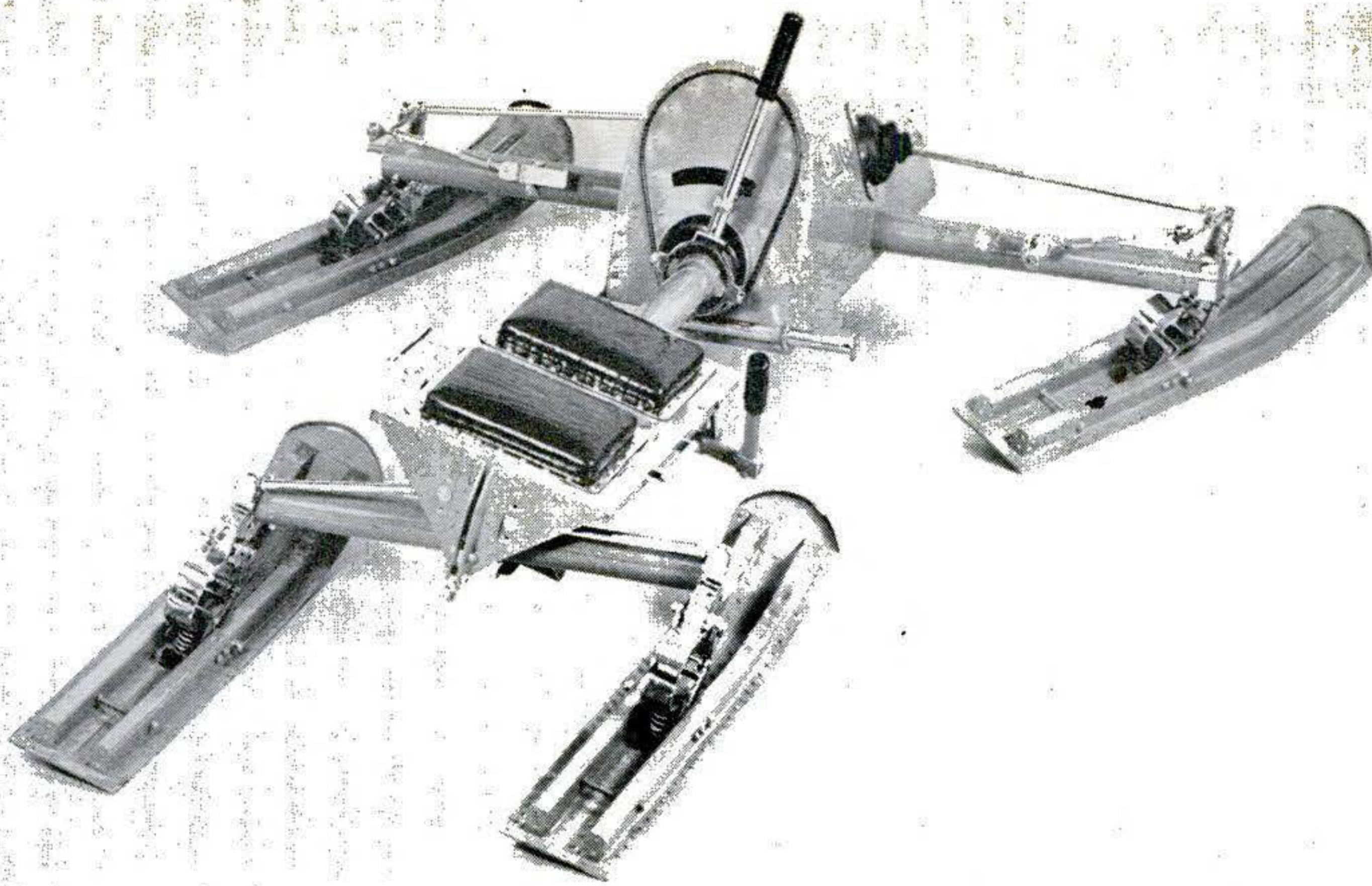
Bonus use for Lockheed's wind tunnel may help U.S. skiers win February's World Games in Italy. Testing for best tuck position is Judy Nagel, a prime contender. Wired to a drag-measure dial and blasted with a 70-mile wind, skiers can read the dial to judge if changes in stance lessen resistance.



◀ A jack for Jills

Flat tires happen to us all—including those to whom the use of an auto jack is a messy mystery. B. F. Goodrich now solves the problem with a one-piece rubber jack. Inflated in seconds with bottled air or gas (three minutes with pump), it blows up 21 inches tall to lift a tire well off the ground.





For lazy skiers

Tired of standing on those long downhill runs? Here's a sled that lets you duplicate skiing maneuvers with a control stick. Both pairs of skis bank; front ones also pivot, and toe-in for snowplowing. There's a drag brake for stops. And if you're really tired, you attach a power unit. Sit-N-Ski costs \$250.

Tilt-wing rescue plane >

Night sea rescues like the one in this painting would be feasible with the unique transport Boeing is proposing to the Air Force. The wings—and props—pivot up for vertical takeoff and landing or for hovering. As a conventional plane, it could fly 1,000 miles at 400 knots, then search for an hour.



◀ Cars travel vertically

No, this new compact isn't being mashed into a cube of scrap metal—it's being loaded for transport. An 89-foot railway car (developed jointly by GM and SP) carries 30 small autos nose-down on panel ramps—twice as many as tri-level rack cars. It's sealed against weather and vandals.

What's New IN TOOLS

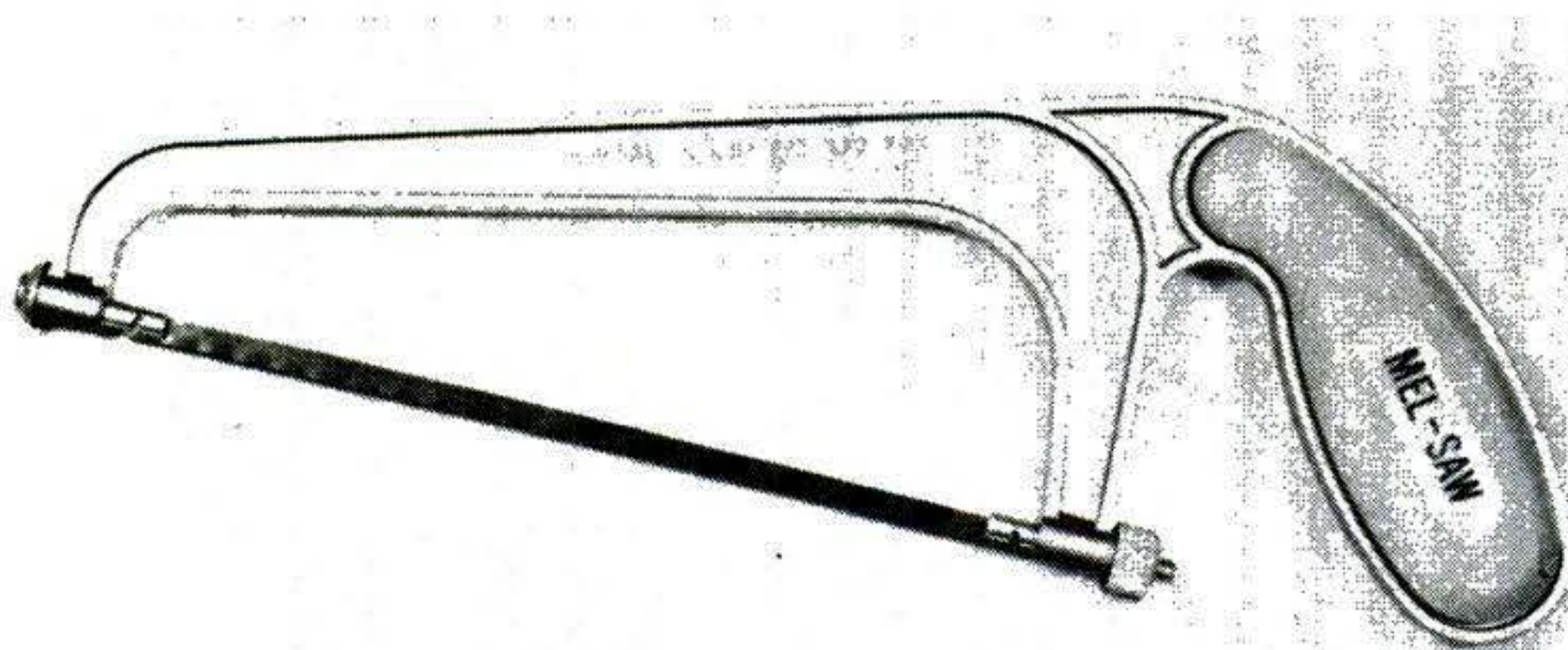


← How's this for impact?

Attachment that converts any $\frac{3}{8}$ - or $\frac{1}{2}$ -inch drill into an adjustable-torque impact wrench is offered at \$24.95 by Nebraska Machine, Box 12214, Omaha 68112. Tight-N-Fast accepts standard drive sockets and blades for screws.

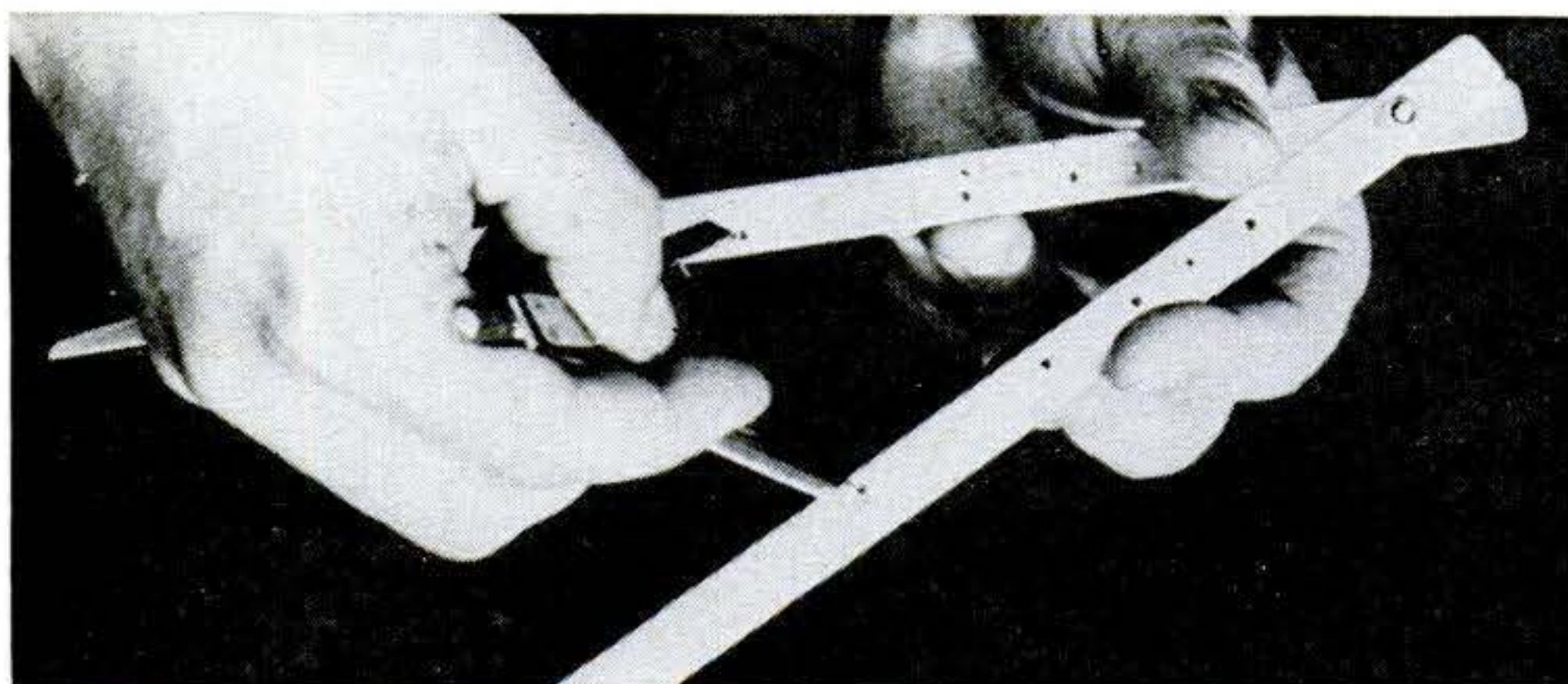
▲ Won't shake you up

Two glasses of water on the CP-70 demonstrate vibration control in McCulloch's new Cushioned-Power chain saws. Glass set on engine housing splashes, while one between handles stays calm. Models also feature sound-suppression.



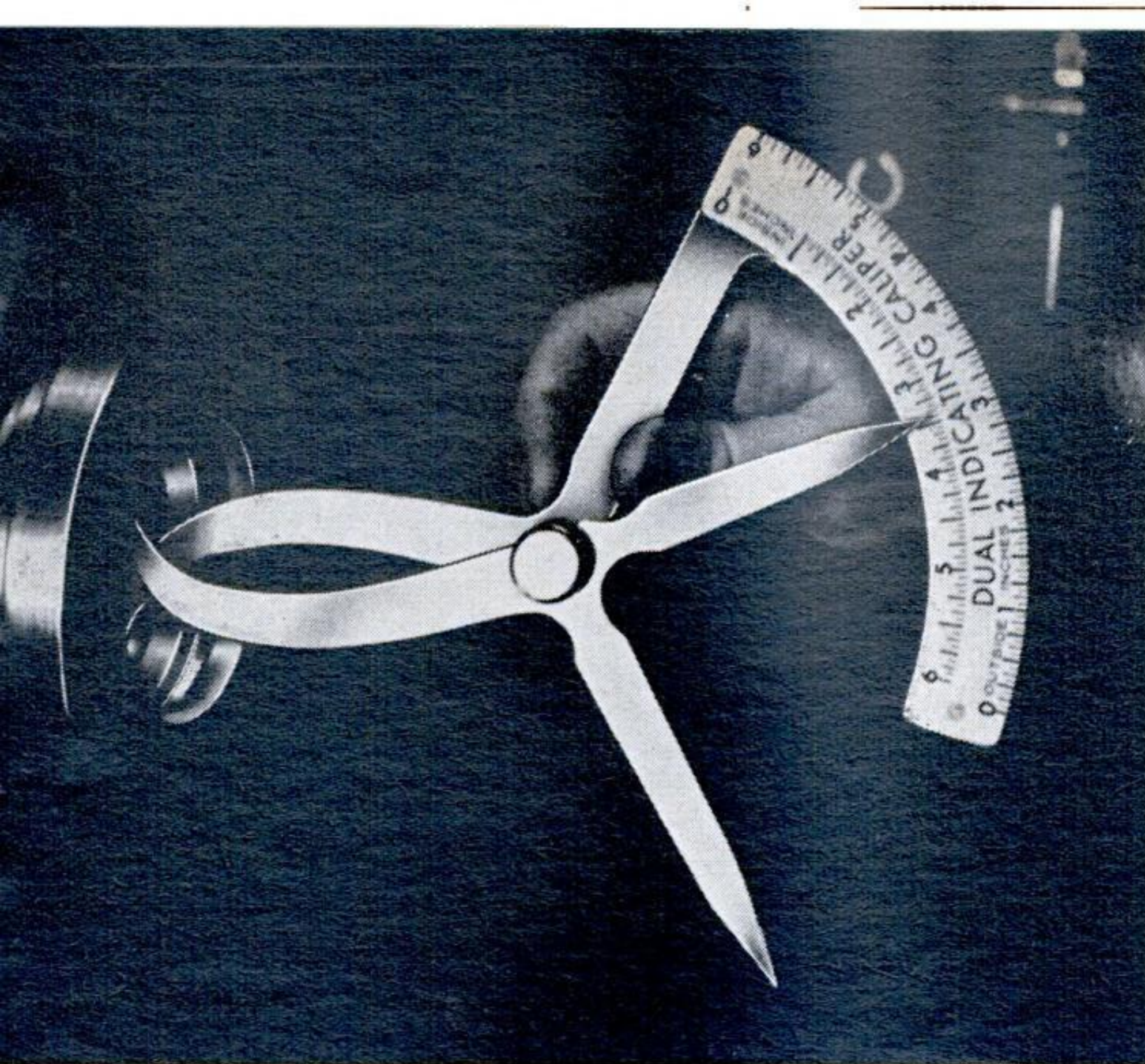
← For all hackwork

Designed for mechanics, the Mel-Saw boasts a compactness, pistol grip, and six-position blade adjuster that qualifies it for household jobs. Mel-Enterprise, Leipsic, Ohio 45856 will ship it for \$3.45. It takes flat or round blades.



← The great divider

You can divide lines in equal or proportional segments with Poly-Vector to simplify layouts or sign painting. Steel legs have a self-locking pivot. Distance between pairs of dots is $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, and $\frac{1}{7}$ the distance between points. \$10. from Silver Circle, 4545 Cameron, Portland, Ore. 97221

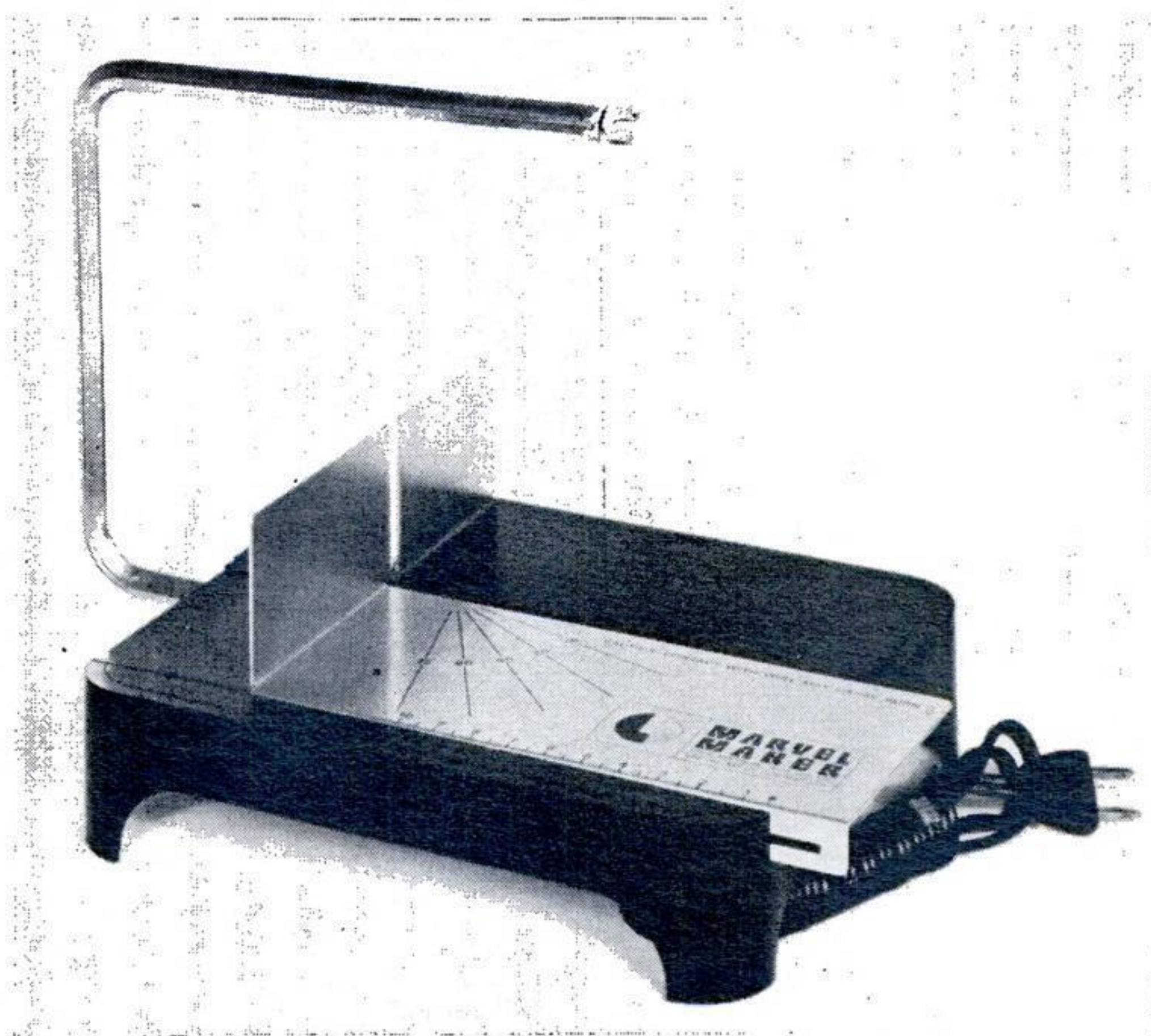


▲ Reads two ways

An attached scale on this direct-reading caliper is calibrated twice for inside and outside readings with different pointers. Curved legs reach over flanges to measure sections as much as four inches from an edge. It's \$12 from Indicating Caliper Co., Box 51, Oak Park, Ill. 60303.

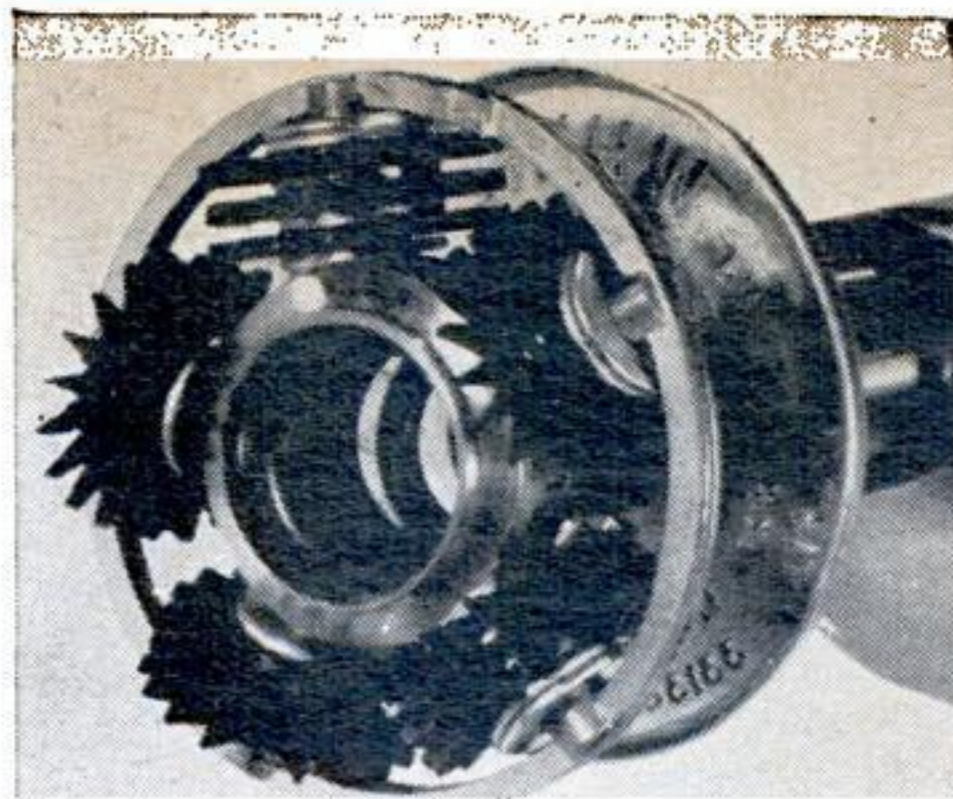
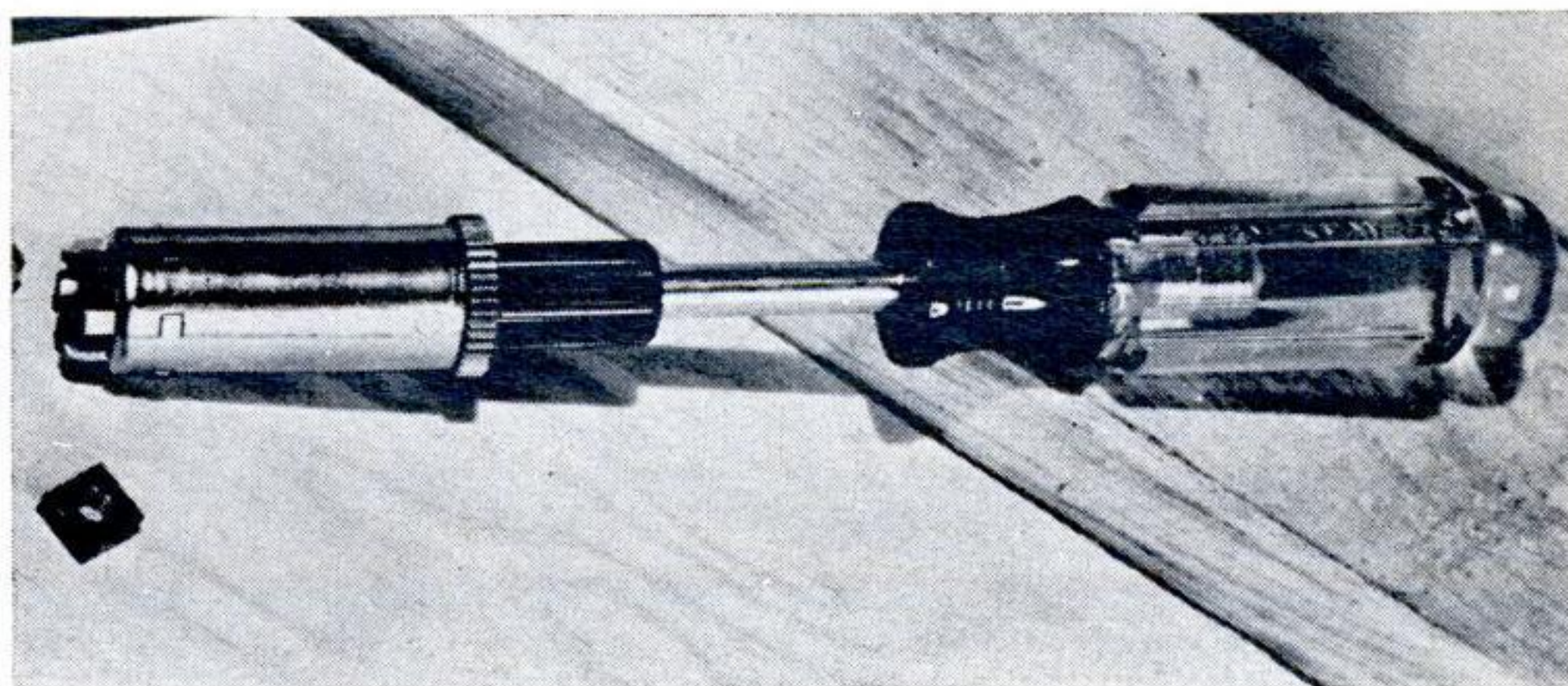
It doesn't saw ➤

At last, a precision tool that cuts polystyrene foam or styrofoam for pattern making or model work. It cuts like a jig saw, but in place of a blade is a heated wire that melts its way in any direction up to six inches deep. Called Marvel Maker, it's \$12.95 from Lancer Industries, Goleta, Calif. 93017.



All-size nut driver ➤

Six variable jaws lock tight on hex nuts and bolts to hold them for easy starting and removal in tight spots. It grips tighter the harder you twist the shockproof handle, while a plastic shaft bushing helps reduce wrist action. \$4.89 in Sears, Roebuck fall catalog and available at Sears stores.



Whirl away rust ▲

Toothy attachment for a 1/4-inch drill bites through heavy rust, paint, or barnacles to clean up steel or concrete surfaces. The 15 cutters last about 150 hours (at 1,800-3,000 r.p.m.) A new set is only \$2.50. The model 305 Whirl Away is \$14.95 ppd. from Goodmark Sales, 16007 Kingside Dr., Covina, Calif. 91722.

What's New FOR YOUR CAR

Double steering wheel ➔

Dual-wheel steering can be installed on any car. Two nine-inch wheels set 16 inches apart give you a faster ratio for sportscar-like cornering and afford greater safety in the event of collision. Kit is made by Road Devices, Syosset, N.Y., costs \$198.95, and can be transferred to a new car.

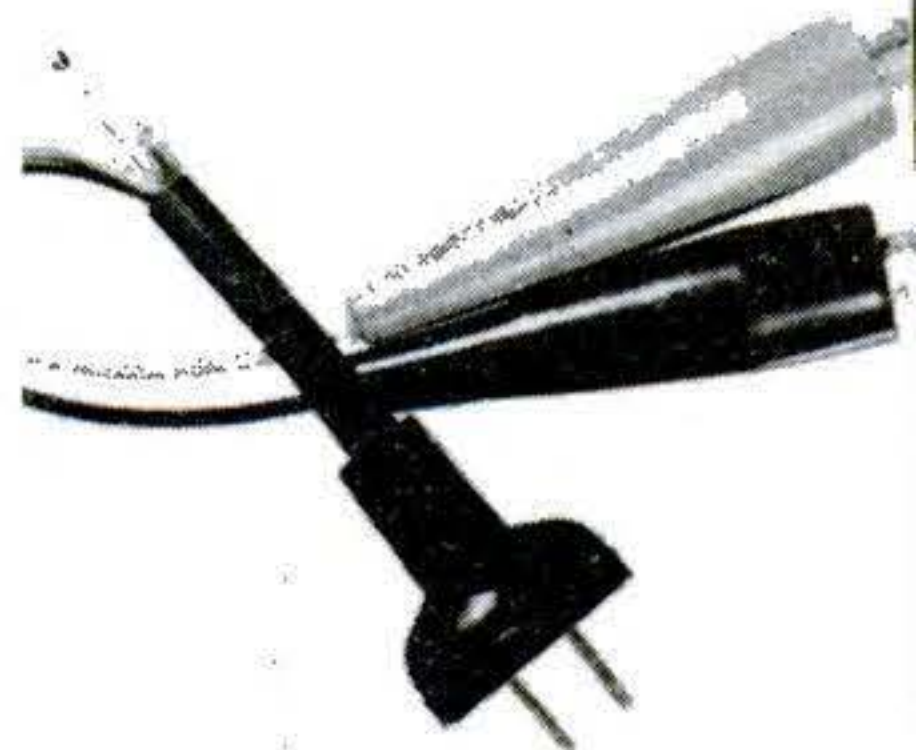


◀ Use it or it buzzes you

Scribe Seat Belt's buzzing signal reminds you to buckle up when the car or seat moves—unless your belt is fastened. The battery-powered device doubles as seat-belt retractor. It's made by Hutchings & Assocs., 777 N. Michigan Ave., Chicago, Ill. 60611. The price of this one is \$4.

Pocket charger

This handy battery charger has solid-state circuitry that cuts the size of unit, yet gives a full charge to your car or boat battery. It will not overcharge your battery, even if you leave it on for a year. It's available from McCurley & Co., Drawer 16505, Mobile, Ala. 36606 and costs \$5.25.



◀ Analyzer in a kit

This easy-to-build Knight Analyzer kit makes tuning-up and trouble-shooting your car lots simpler. The compact device can be used on four-, six-, or eight-cylinder cars with six- or 12-volt electrical systems. The KG-303 Junior Auto Analyzer is available from Allied Radio, Chicago, for \$20.



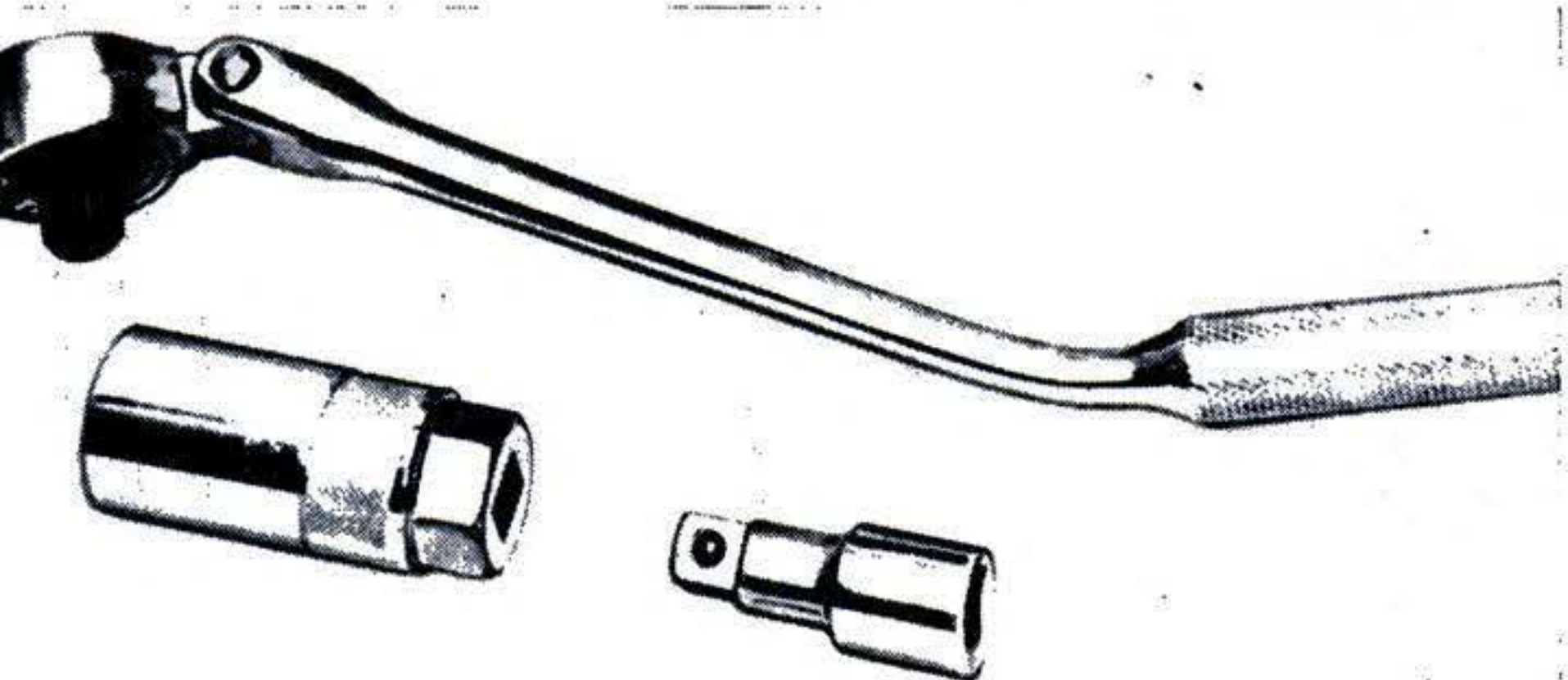
Foreign-car console kits

You can install a console in your foreign car in five minutes with one of these add-on units. They attach with three sheet-metal screws; each model is customized to fit precisely in place. Prices for the consoles, made by Autodeco, Inc. of Framingham, Mass., start at \$10 for VWs.



Remote spray "chains" ▲

You simply push a button on your dashboard to spray Liquid Tire Chain on for added traction in ice and snow. The push-button device was developed by GM's AC Spark Plug Div., and uses aerosol cans of a spray made by Dow Chemical Co. The compound triples traction effectively for several miles of highway driving.

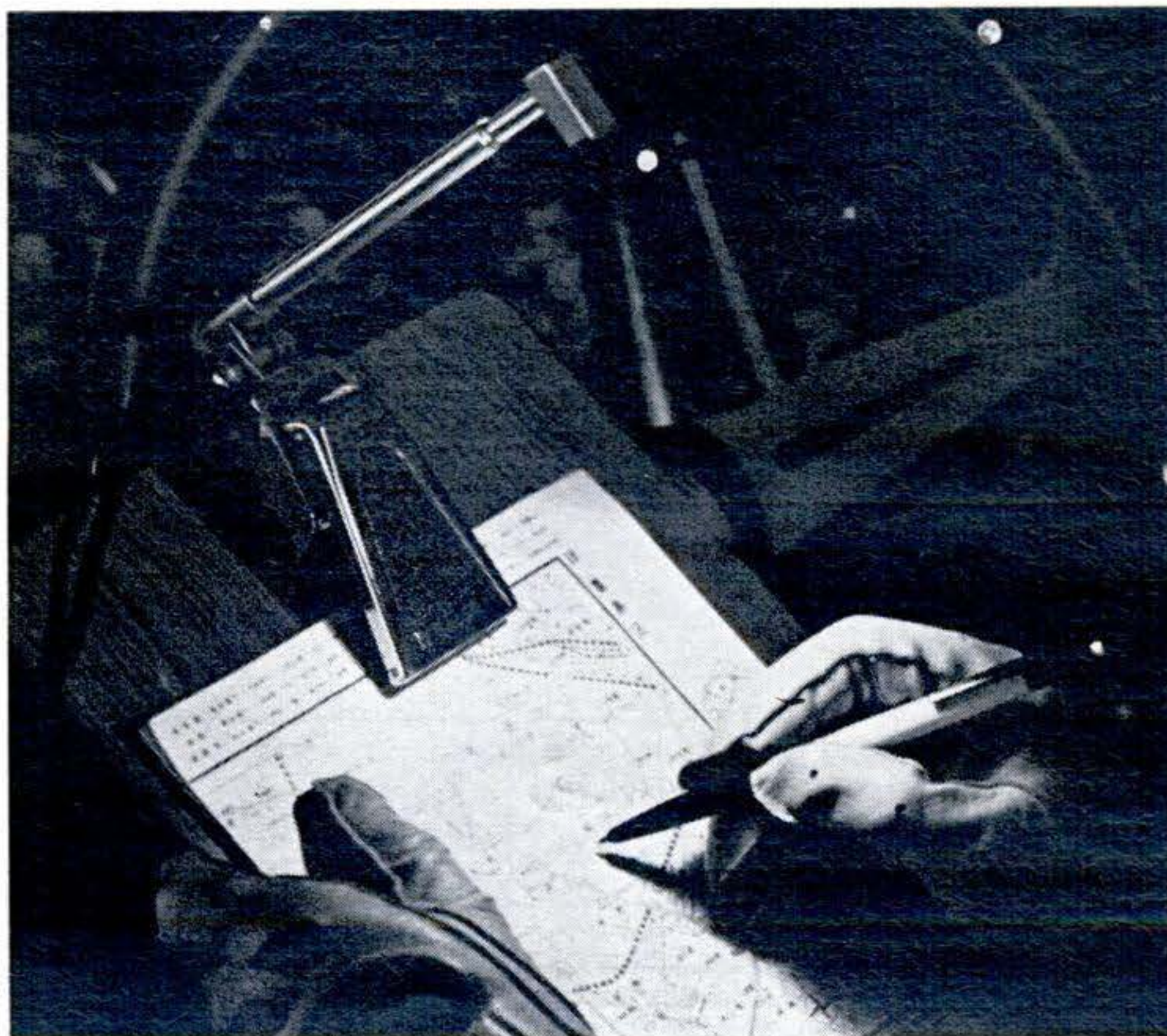


Gyro-flex ratchet wrench

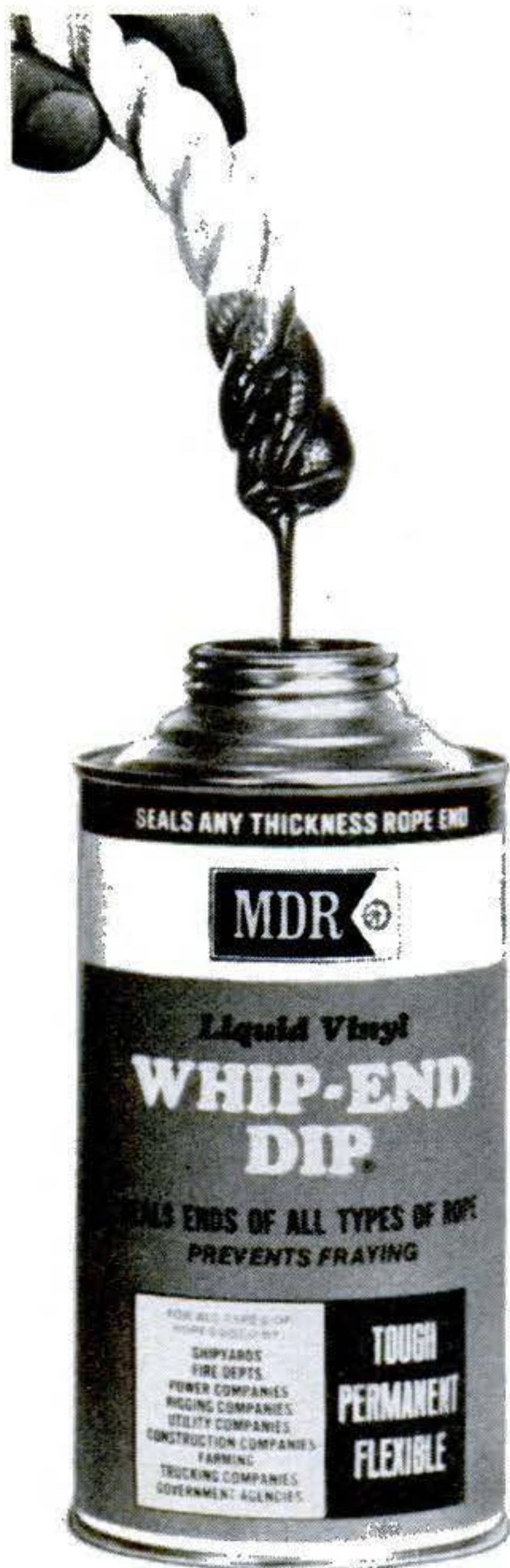
This new spark-plug tool makes working in tight areas easier with its double-offset handle. It allows you to turn the tool in any direction and work around obstructions. It can also be used to turn hard-to-reach bolts. It's made by New Britain Machine Co., New Britain, Conn. About \$10.

Lighted clipboard ➔

The Clipper gives you a lap desk plus a high-intensity lamp to use in or around your car. The 12-volt line plugs into your car's cigar lighter, and it's long enough to use as an auxiliary light when you're making emergency repairs. You can get it from Commonwealth Industries, Newton, Mass. 02158.

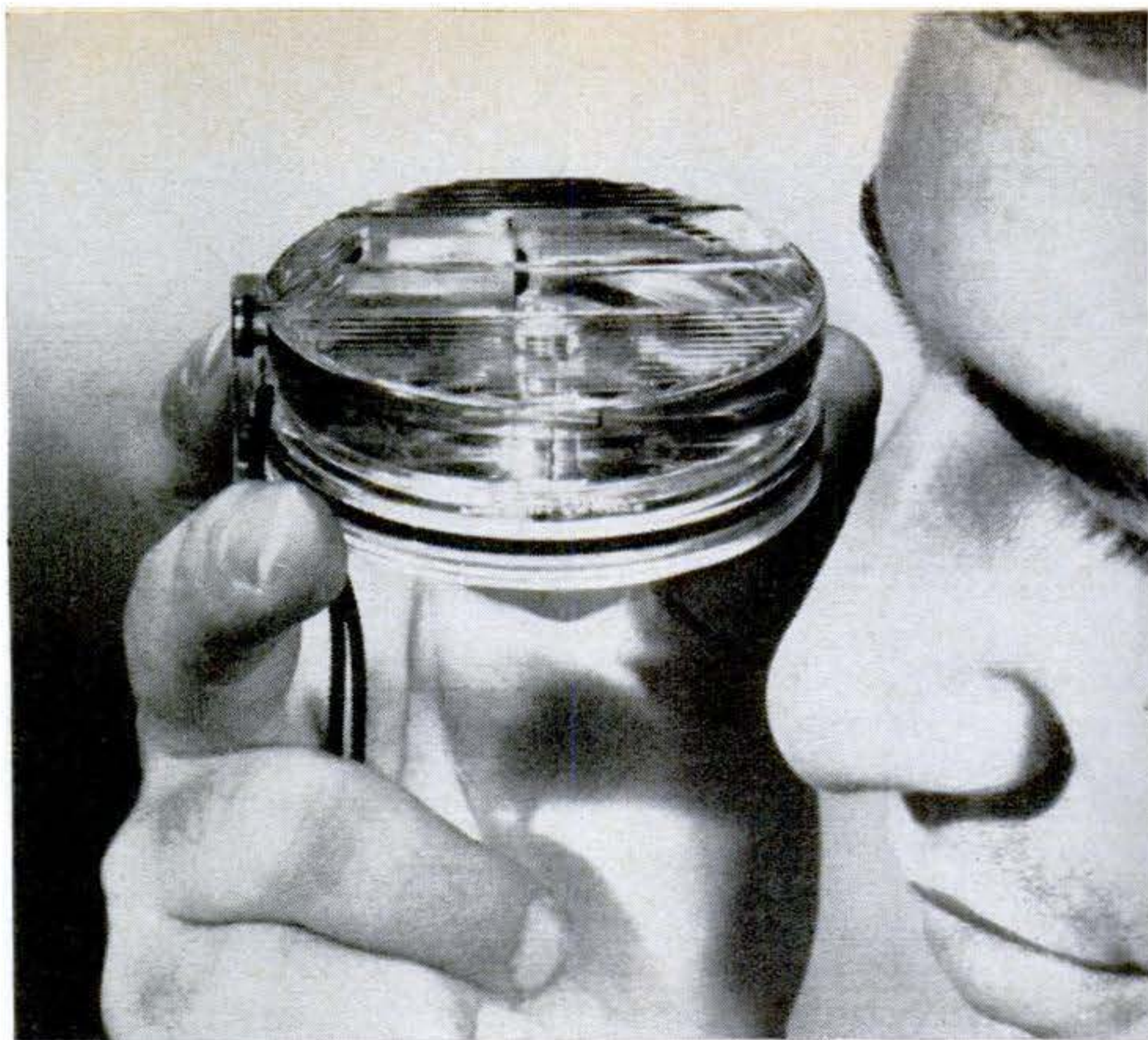


What's New IN BOATING



Mooring line snaps on ➔

A squeeze on the Bear Claw Brush Anchor quickly fastens it to a shore-side tree or a dock. The steel claw has six feet of braided nylon cord attached; both can handle pulls of up to 500 pounds. A pair cost \$3.95 at dealers or from M & B Sales, 2615 Love Field Dr., Dallas, Tex. 75235.



▲ See-through compass

A prism in the plexiglass case of this bearing compass magnifies degree markings 10 times and "projects" them on the landscape. The liquid-damped card is luminescent for night use. Ermont Sales Co., 3701 Kirby, Suite 834, Houston, Tex. 77006 imports the Morin compass from France.

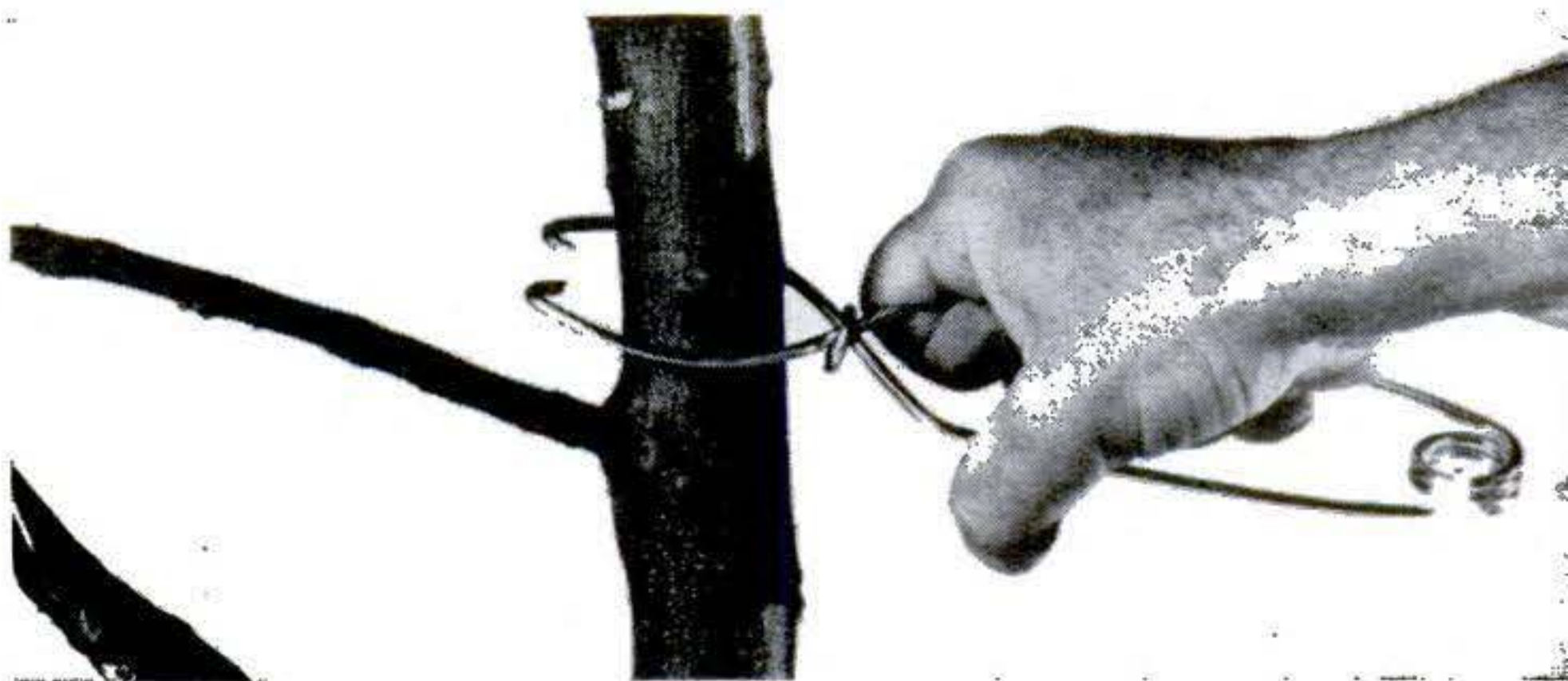


◀ Just dip to whip

One dip in this liquid vinyl cures an old boating disease: frazzled rope end. The red coating hardens on any kind of fiber to a tough but flexible seal—resistant to water, gasoline, oil, and acids. A quart can of Whip-End Dip is \$9.95; four ounces cost \$2.98 at marine dealers.

Man the pumps! ▲

Sea Alert blows the horn on leaky bilges. Rising water sets off a loud warning tone from the self-contained device. Model Z100 is only three inches in diameter, two inches thick. It retails for \$24.95 from Zeigler Electronics, 17810 South Western Ave., Gardena, Calif. 90247.

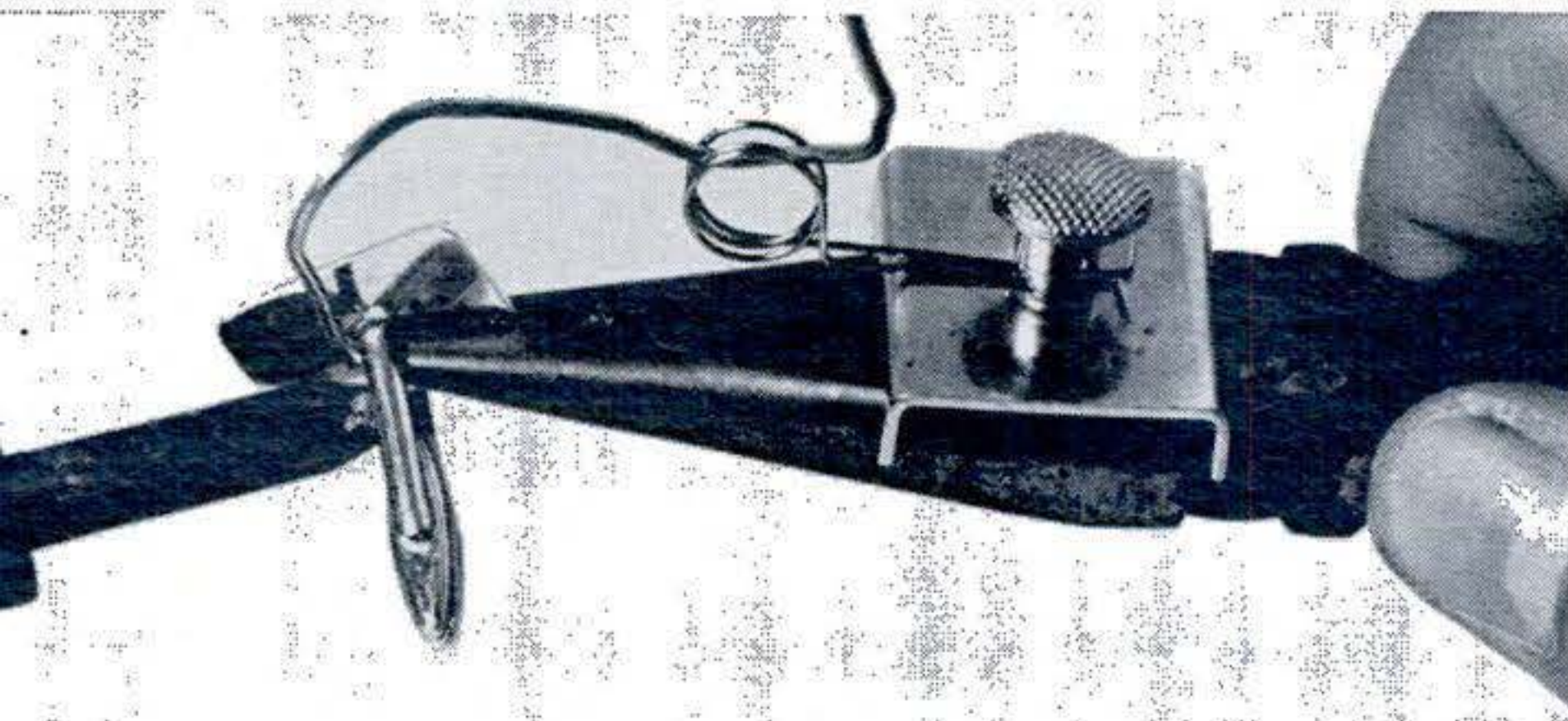


What's New IN ELECTRONICS



◀ You're on the air

Here's a first in stereo receivers—a microphone input circuit with its own level and mixing control. Plus use as a public address system, it lets you sing along with a record while it's coupled with a tape recorder. Receiver is Pioneer's 180-watt SX-1500TD from Japan. Costs \$400 with a dynamic mike.



◀ Third hand for soldering

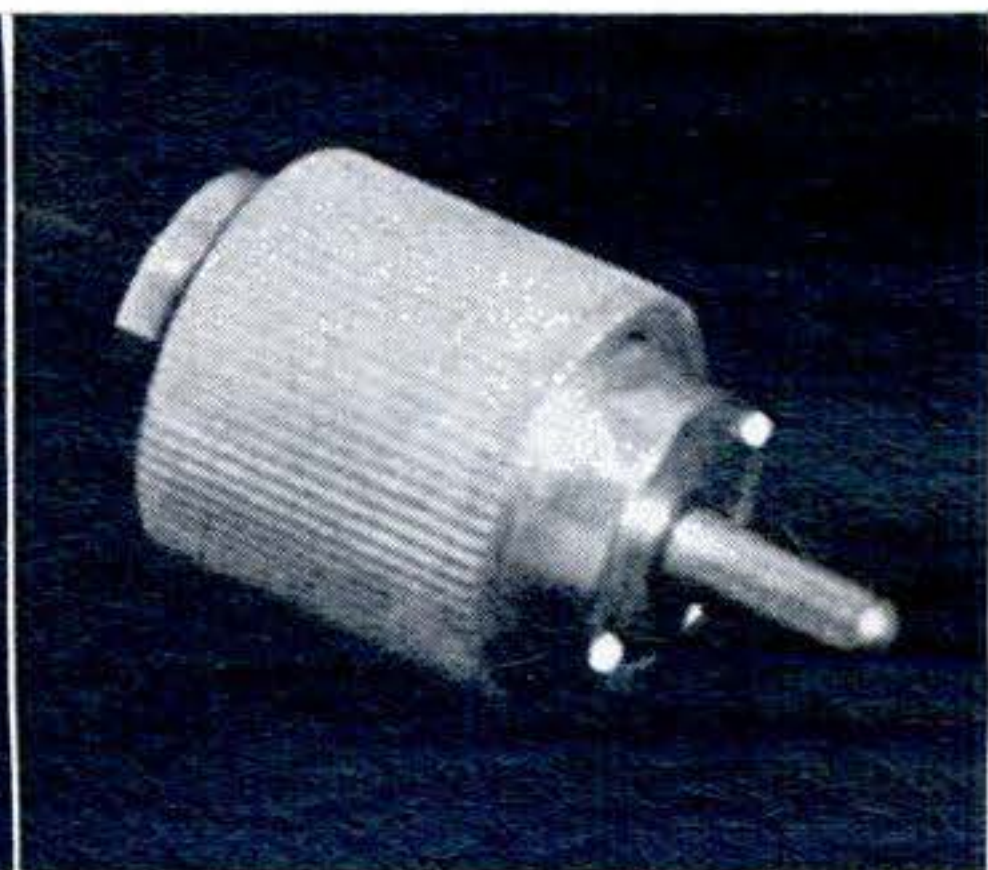
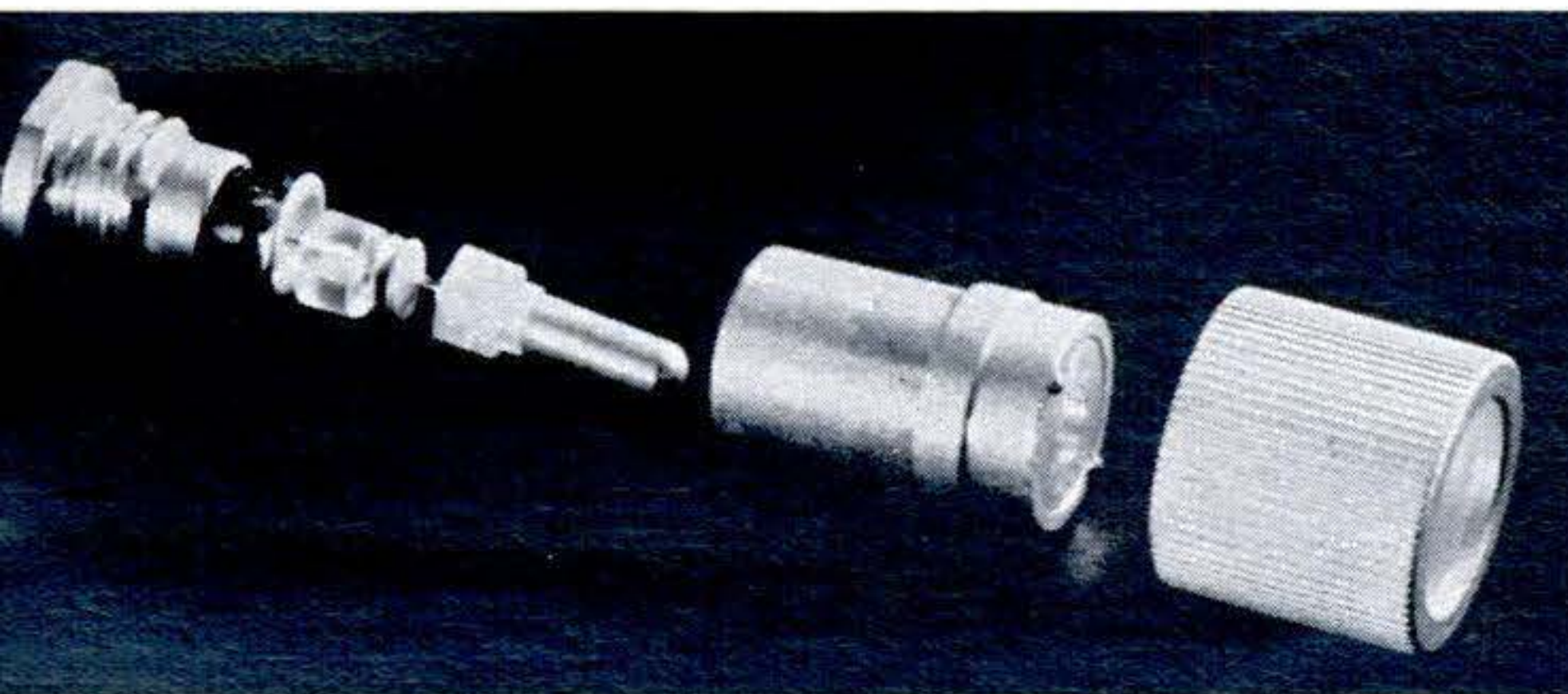
How do you feed the solder while you hold your iron and the job—with your teeth? This little magnetic caddy solves the problem. Grasp the part in your pliers or vise, set the caddy in place, then insert a length of solder in its spring clip. \$1 from Solder Jockey, Box 1427, L.I. City, N.Y. 11101.

Solderless connector

takes only seconds—and no special tools—to assemble this 259 developed by Gold Line Connector, Box 893, Norwalk, Conn. 06852. A boon to the ham or CBer, it needs only one cut to the inner conductor, and is easily removed for reuse. The parts are lined up below and assembled at far right.

Six-band portable ▶

This solid-state radio—Allied's 2660—covers international short-wave, police, fire, U.S. weather, Ham, and emergency VHF plus FM/AM bands. It sells for \$70, including four D cells, earphone, power cord, dual telescoping 27-inch FM-SW-VHF antenna and case. It measures 6 by 12 by 16 inches.

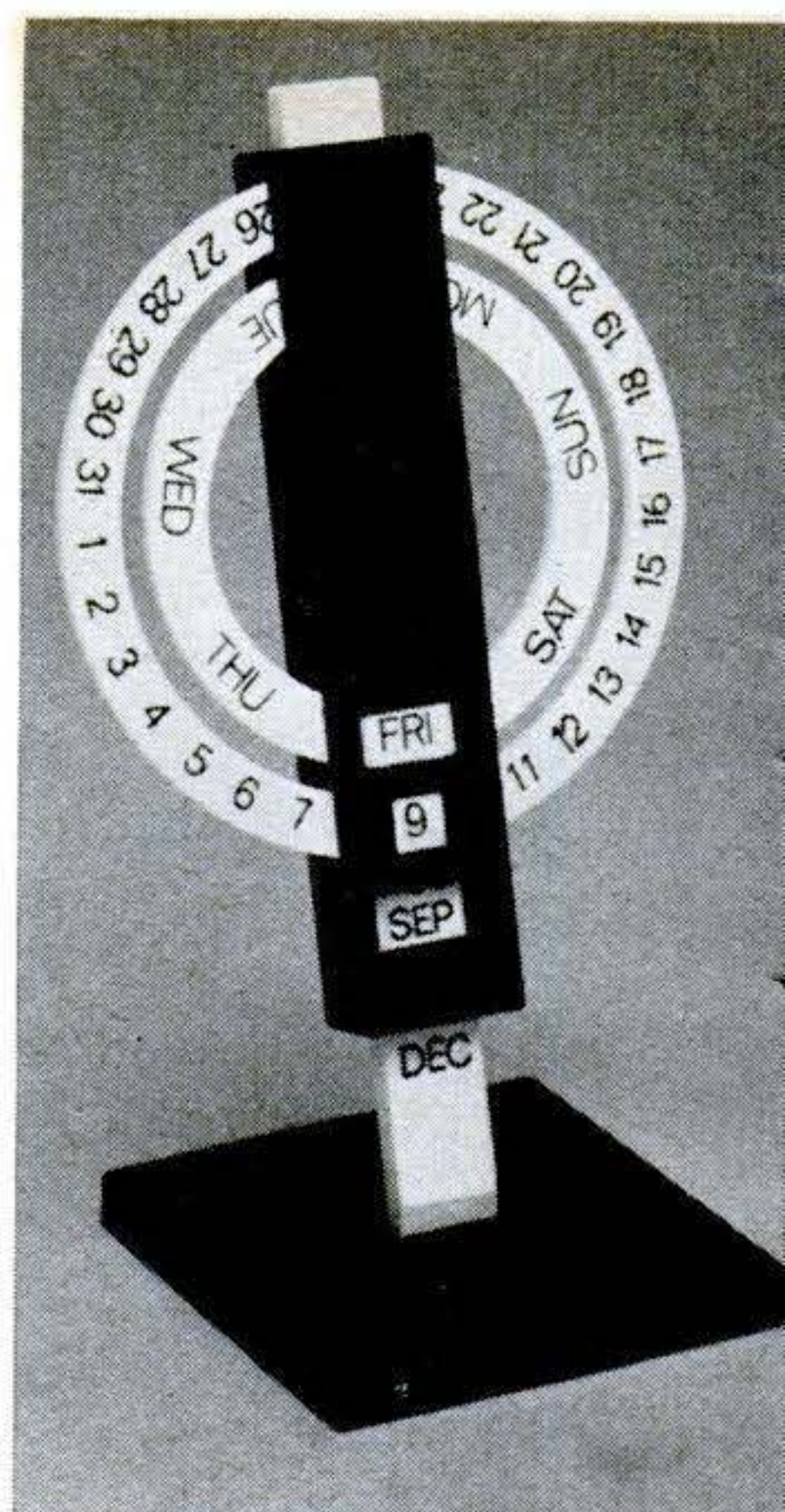


What's New

IN HOME IMPROVEMENT

▼ Peel-and-stick paneling

If she's tired of nagging you for a paneling job, she can now do it herself. Decro-Wall's Wood Tone consists of self-stick 6"-by-24" rigid styrene panels that reproduce grooving and natural grain of six woods: light/dark walnut or oak, plus teak and rosewood. A \$4 package covers six sq. ft.



All year 'round

You rotate the concentric rings of this smartly designed permanent calendar of black and white plastic to bring day and date into the upper windows.

Black body slides down to show the month. It's seven inches tall in January, five in December. \$2 ppd. from Calendar, 326 E. 70 St., N.Y., N.Y.



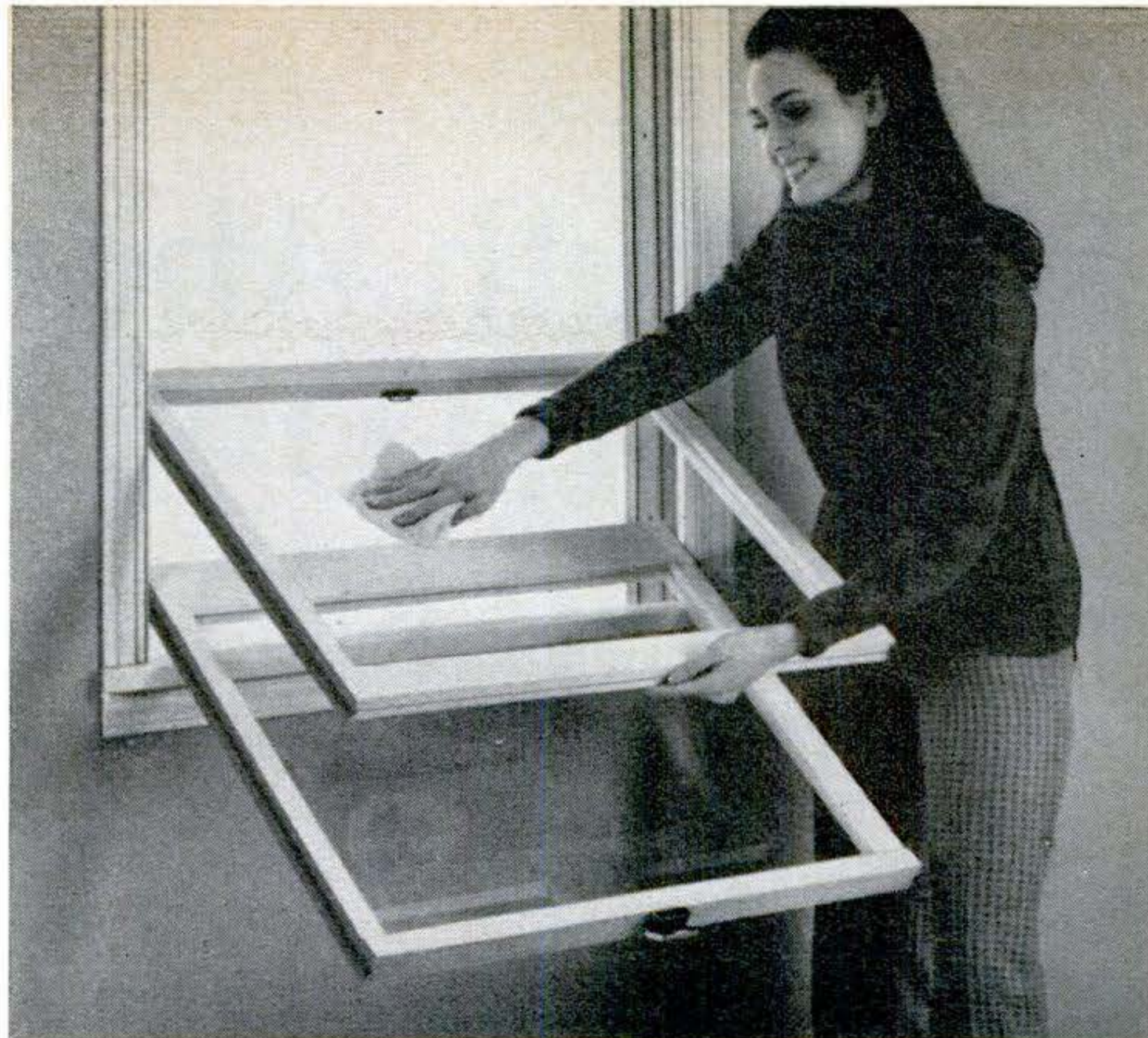
Snarl-free wire

At last: a sensible package for household wire that works like a string dispenser. A steel cage keeps the supply untangled, lets you reel off just what you need and provides a cutter notch. USM Corp. offers three gauges (ranging from 17 to 24) in galvanized (\$1.19) or nylon-coated wire (\$1.29).



Faucet cartridge

This solid brass, chrome-plated cartridge for all single-handle Moen faucets is self-adjusting/lubricating and completely renews the faucet, since it contains the entire valve mechanism. Held with nonmoving O-rings, it can be installed with screwdriver and pliers. Comes with new Moen faucets.

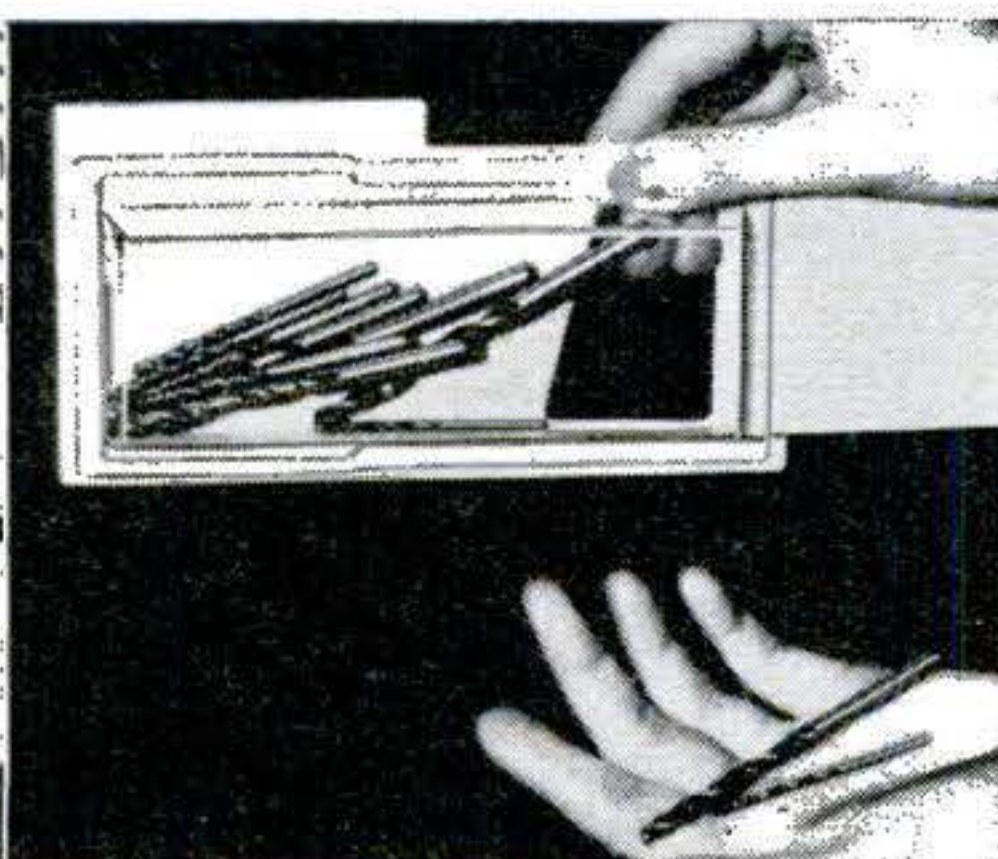
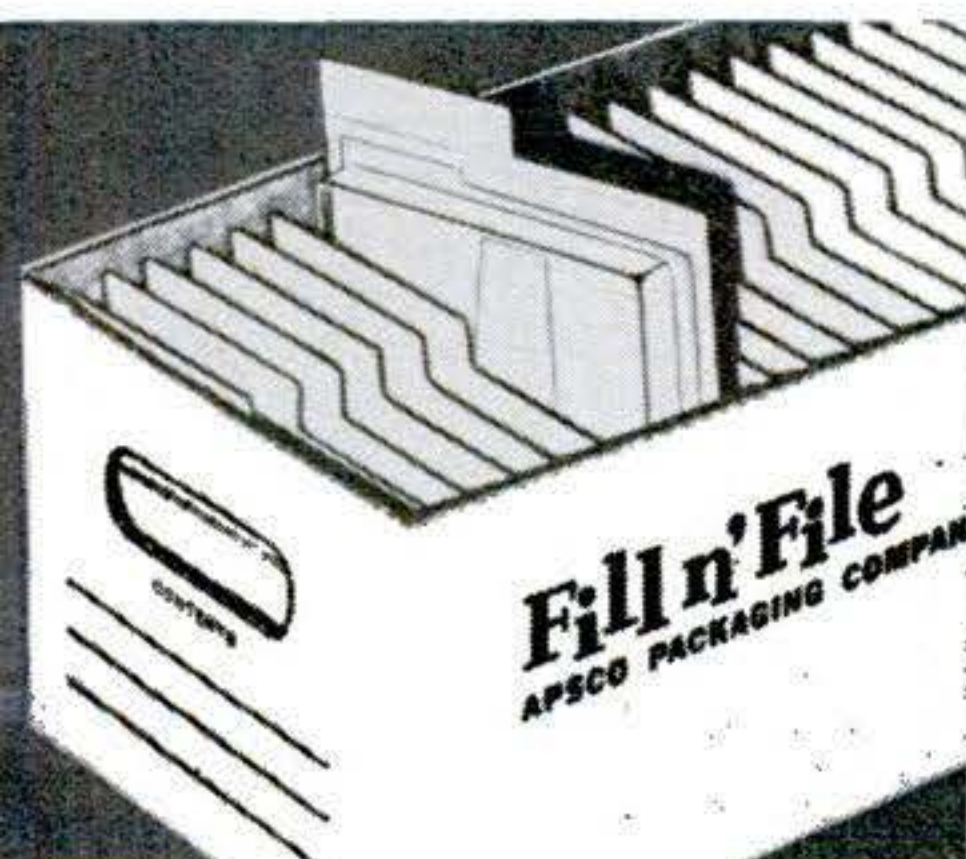
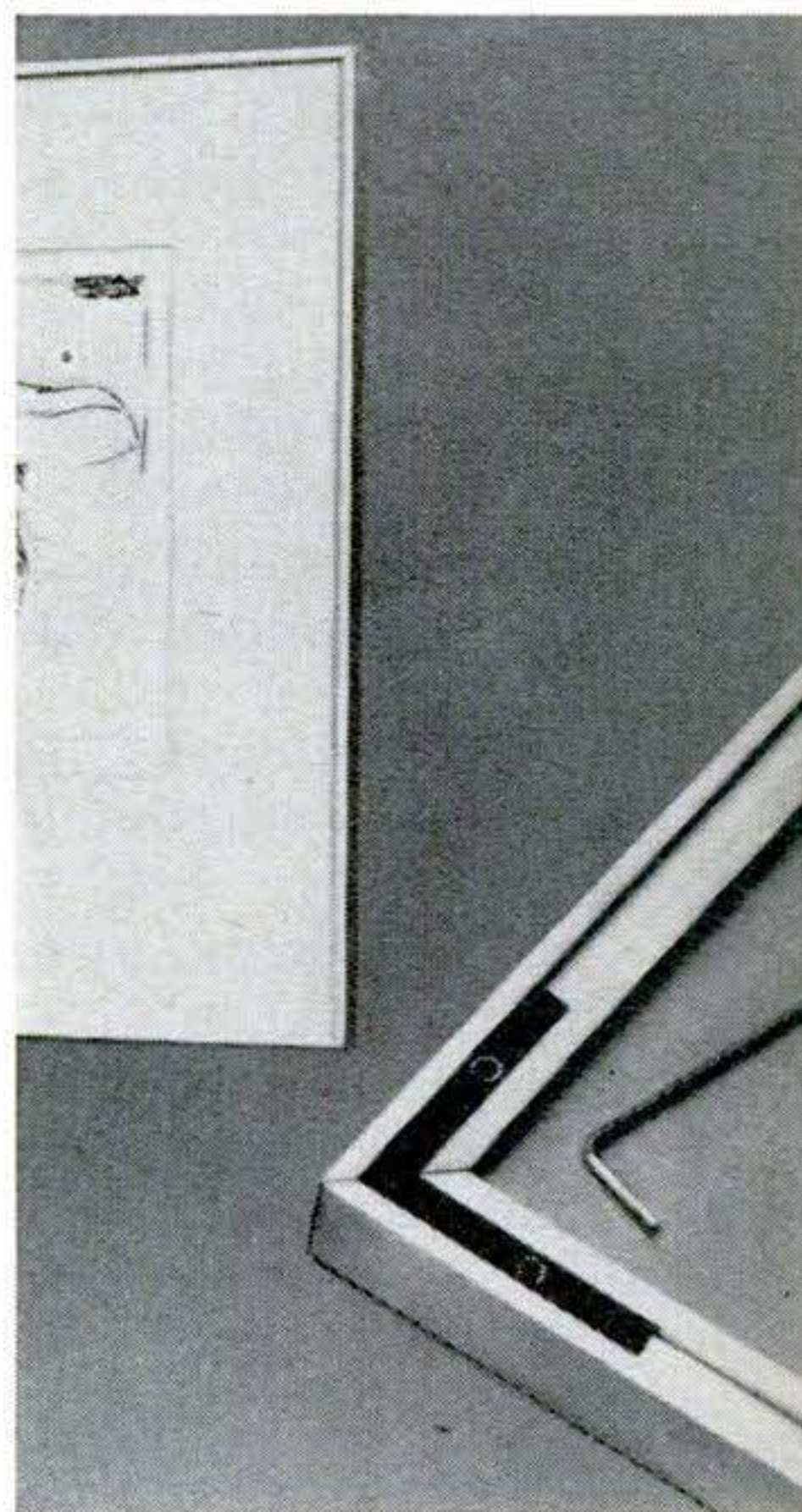


▲ Tilt-in double-hungs

Window work is faster and safer with wooden sash that pivot inside or snap out of the frame. Trim-Tilt system puts slotted vinyl tracks within the frame. Windows slide easily, are rattle-free, and lock securely, yet will pivot without removal of screens or storm sash. Caldwell, Box 444, Rochester, N.Y.

Instant metal frames ►

You can frame prints, photos, pop posters, even original oils in five minutes using buy-in-a-bag Metal Sections from Contract Products, 636 Broadway, N.Y., N.Y. 10012. Sections come in 28 lengths from 8 to 40 inches, \$3.75 to \$7.25 a pair, in aluminum or gold with assembly corners.



◀ File cards with pockets

Small items can be stored for immediate access in Fill n' File trays from Apsco Packaging, 9325 W. Byron, Schiller Park, Ill. Each index card has a plastic pocket with slide-out door. Insert small bits, nuts and bolts, fishing lures, then label the tab and file. Cards come in 3-by-5 or 4-by-7 size.

The Truth About LIMITED-SLIP DIFFERENTIALS

Our test cars were identical except for the differentials—one standard, one antispin. The results will surprise you

By JAN P. NORBYE / *PS Automotive Editor*
and JIM DUNNE / *PS Detroit Editor*

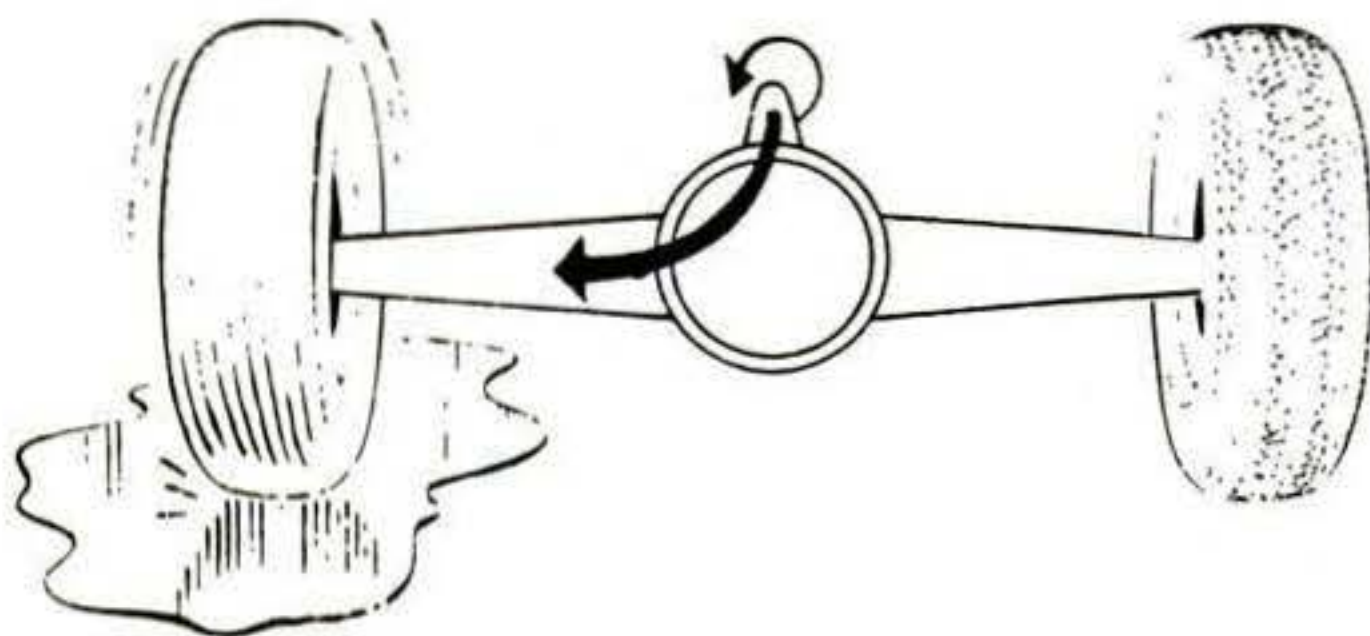
You may have driven cars with limited-slip differentials for many years. Maybe you feel they've gotten you out of spots where a standard axle would have left you stranded. Or maybe you think they don't help you much, if at all. You may even feel that the drawbacks of an antislip unit are greater than the advantages. But what do you *know*?

To get the facts on just what a limited-slip differential contributes to mobility under slippery conditions as well as on dry roads, we drew up plans for a series of tests. Not lab tests, nothing theoretical, but full-scale vehicle tests on real ice.

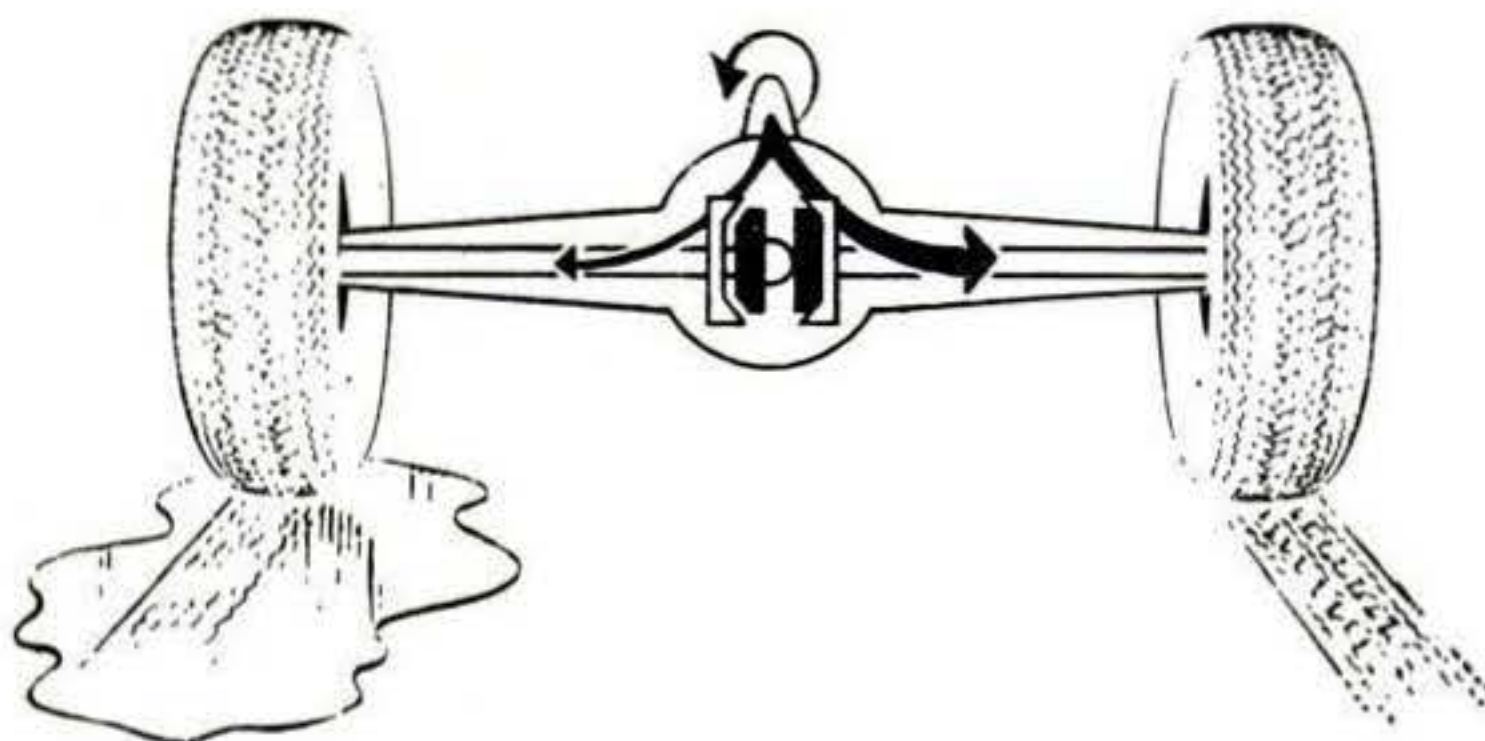
To get positive proof of the effect of an antislip differential, we had to isolate all other factors. That meant getting two test cars, identical except for the differential. Oldsmobile agreed to cooperate, and came up with two 4-4-2 hardtops, weighing within 20 pounds of each other, both equipped with Turbo-HydraMatic transmission.

Both test cars had Firestone F70-14 polyester cord tires. One set was brand new; the other had rolled 1,000 miles. There was no measurable wear on any tire, but this small difference in mileage was to play a critical part in one of our tests.

How the axles differ. Before we talk about the test, let's take a quick look at what standard and limited-slip differentials are. In the standard axle, the only



With standard differential (above), a car with one driving wheel on ice fails to move ahead because wheel with good grip transmits no more torque



than the spinning one—and that can be zero. With limited-slip differential (right), gripping wheel gets more torque than spinning wheel, and car moves.





Chained to each other, the two 4-4-2 Oldsmobiles in Popular Science test pull in opposite directions. Each car has one rear wheel on ice, the other on

dry road. Predictably, the car with the antislip axle won the tug-o'-war—pulling the other backwards with both its rear wheels spinning.

connection between the wheels is through the differential side gears. They leave one wheel free to turn at any speed while the other stands still. In the antislip axle, there are multidisk clutches outside the side gears on both sides, connecting the road wheel directly to the final drive, by-

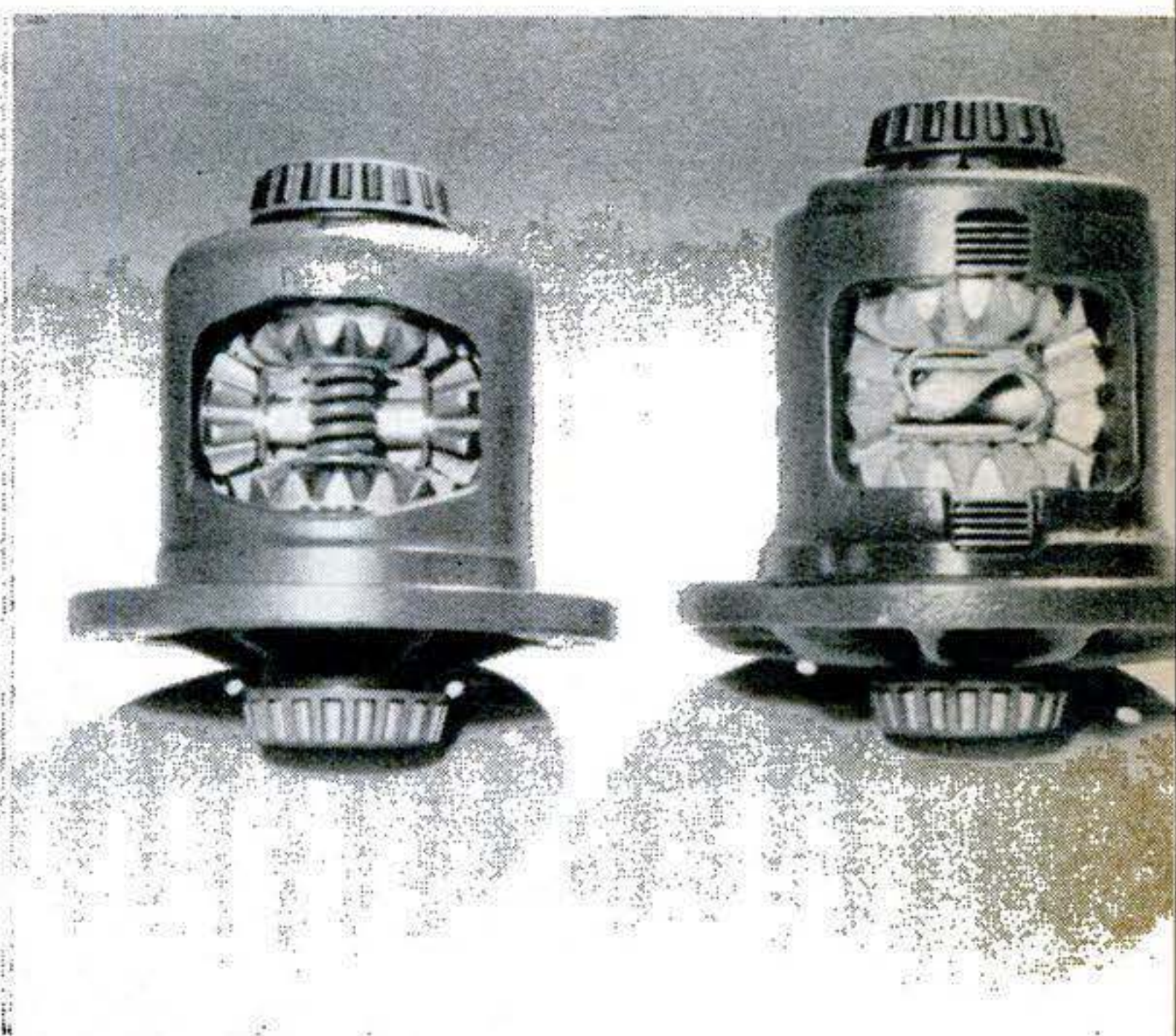
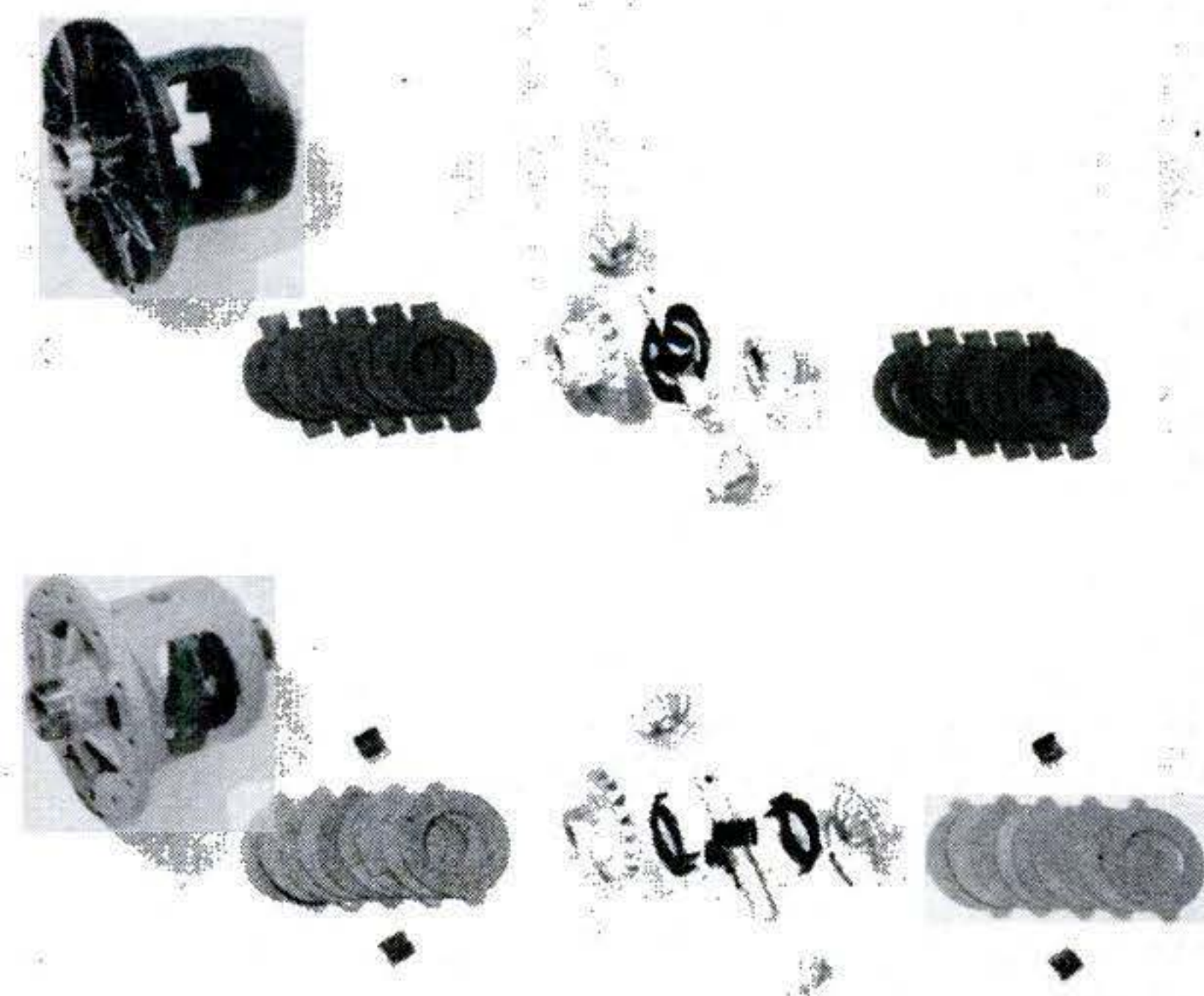
passing the differential side gears, whenever wheelspin occurs.

If one wheel in a standard axle loses traction, it will start to spin, and no more torque can be applied to it *or to the opposite wheel*. With an antislip differential,

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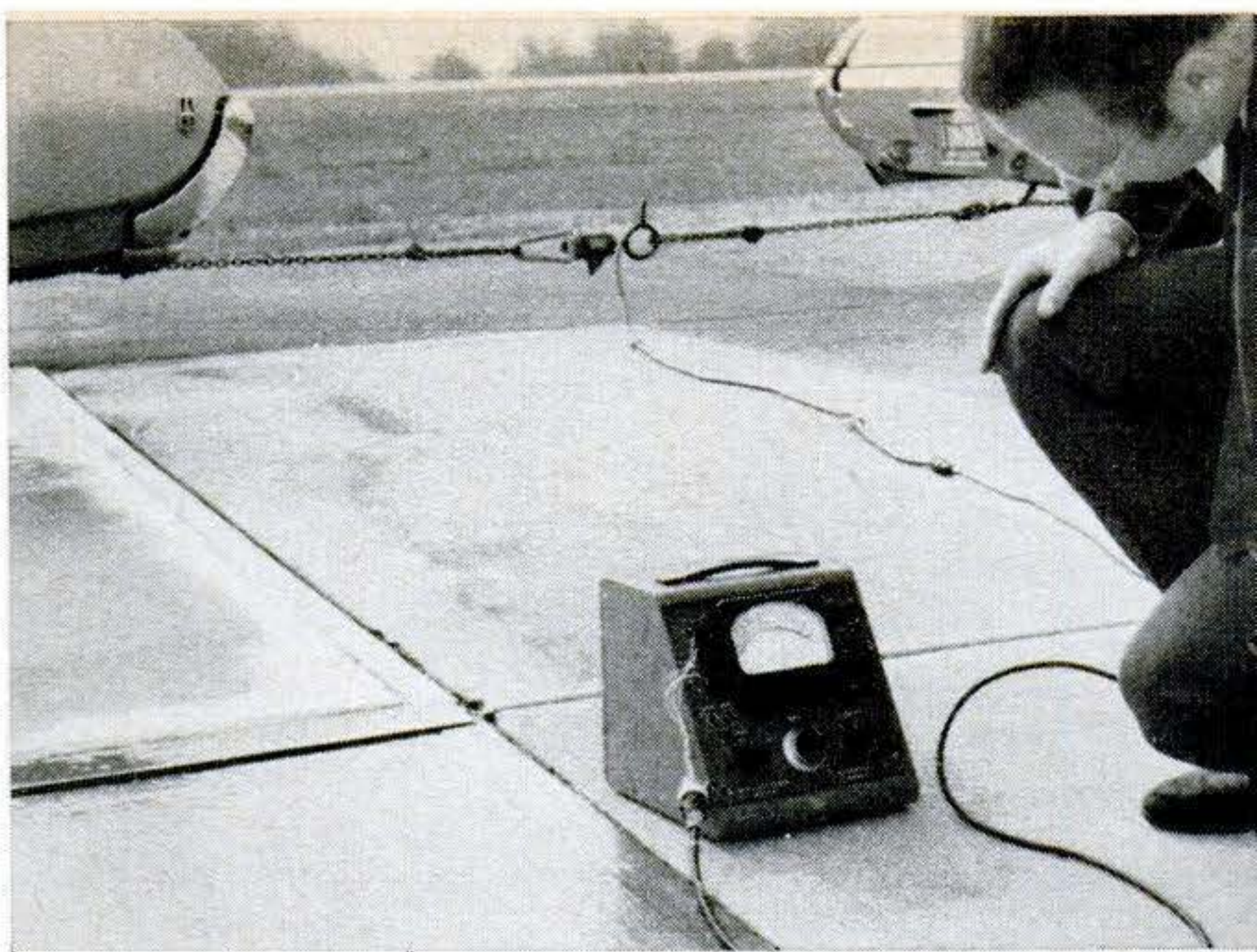
Two types of GM limited-slip differentials are shown in the photos below: at left, with parts laid out; at right, assembled. Both differentials have multiplate clutches outside the side gears. The Olds type has an S spring between the side gears to

provide a preload on the clutches—the other has coil springs. When one rear wheel slips, a side thrust is exerted by the side gear, and the clutch will engage, limiting the slip. When both wheels grip, side thrust is relieved and clutches disengage.



How PS measured traction on ice

Drawbar pull was measured (in pounds) with this instrument. It is adjusted to cancel out the weight of the chains, and registers only the horizontal pull produced by the vehicle. Both cars were tested with their two rear wheels on ice, then with one rear wheel on ice and one rear wheel on dry pavement.



the clutch on the side of the gripping wheel will engage as soon as the other wheel starts to slip, and the gripping wheel will get *more torque* than can be applied to the spinning wheel.

Engineers often call the antislips “torque-bias” differentials. The bias ratio is the torque difference between the two wheels, expressed as a multiple of the torque applied to the spinning wheel (slip-wheel torque).

Now, on to the testing. We were given free use of the facilities of the GM Proving Grounds at Milford, Mich. This included a strip of roadway with an underground refrigerator that produces a layer of genuine ice!

First test: drawbar pull. That’s tractive effort—the force that can usefully be applied to drive the car. By parking one car off the ice, we had a stationary object, and we chained the other car to it. We ran tests with both rear wheels on ice, one rear wheel on ice, with and without using the parking brake. You’ll find the results in a chart farther on.

There are some things you should keep in mind when you analyze the figures. The antislip differential sends most of the torque to the slower-moving wheel when both are on ice and both are spinning. This difference in applied torque can make all the difference between moving and being stuck. Our results prove that this is true.

With one wheel on ice and the other on dry pavement, the car with the antislip axle has enough drawbar pull to move off the line almost as if there were no ice at

all. That’s because the torque-bias ratio gets very high and the axle becomes almost solid. But not quite.

We found that even with an antislip axle it was possible to sit and spin one wheel while the other (on dry road) remained still. That’s because there’s a limit to how high the torque-bias ratio can go. We know that 100 pounds of drawbar pull is the maximum for the spinning wheel, and even if the bias ratio should rise to 10:1, the resultant 1,000 pounds in the gripping wheel may not be enough to prevent slippage in the multidisk clutches. So the gripping wheel remains stationary while the other spins.

For drag racing and other competitions, true locking differentials are available, but they’re noisy and cause increased tire wear, and so are not recommended for street use.

We mentioned using the parking brake. We’ll explain. By holding back the spinning wheel, the overall torque load is increased. That increases the separating force on the differential side gears, which adds to the pressure on the multidisk clutches, and increases drawbar pull.

If you’re stuck, despite having an antislip axle, apply the parking brake and try again. Apply it lightly at first, then harder and harder until the car is moving. Don’t use the foot brake; that will hold back the front wheels.

Acceleration test. We tested both cars with both their rear wheels on ice, and both cars with one rear wheel on ice. Surprisingly, the car with the standard axle was faster over a 100-foot run with both



With one rear wheel resting on ice and the other on dry pavement, the car with the antislip axle pulls against a stationary object (the other test car, parked with all four wheels on dry road). The results are given on chart on the following page. Below, with all four wheels on ice, the car with the standard axle was hooked up to the other test car (parked off the ice) to measure drawbar pull. Without use of the brakes, it registered only 100 pounds.



rear wheels on ice! We made a number of runs, with consistent results. Not a shadow of doubt.

Then we switched tires, and made a few more runs. Now the car with the antislip axle (but new tires) was faster, by a sim-

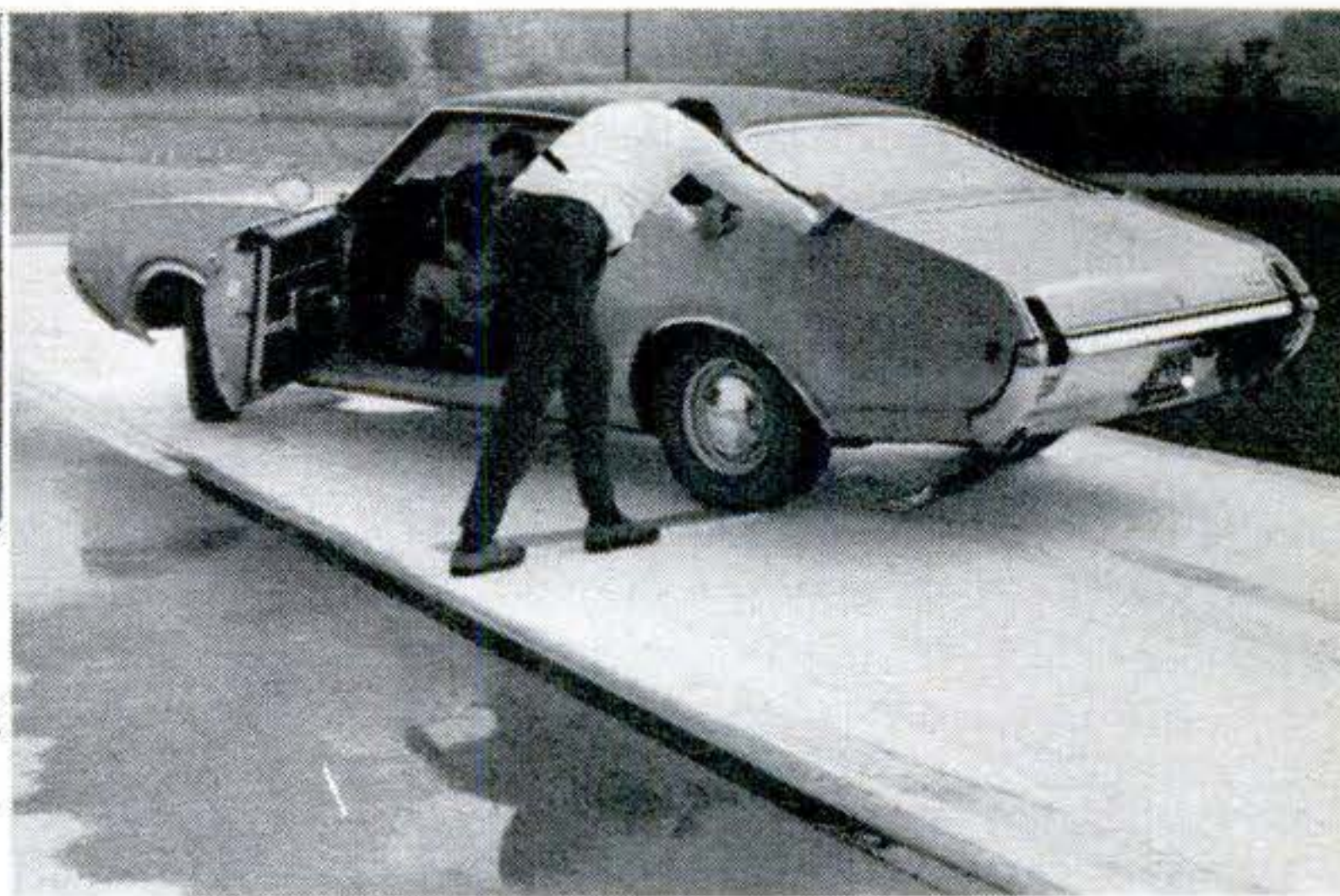
ilar margin. We concluded that on very smooth wet ice, the tire makes the difference. Even as little as 1,000 miles' wear counts!

With one rear wheel on dry pavement, the antislip-equipped car won hands down.

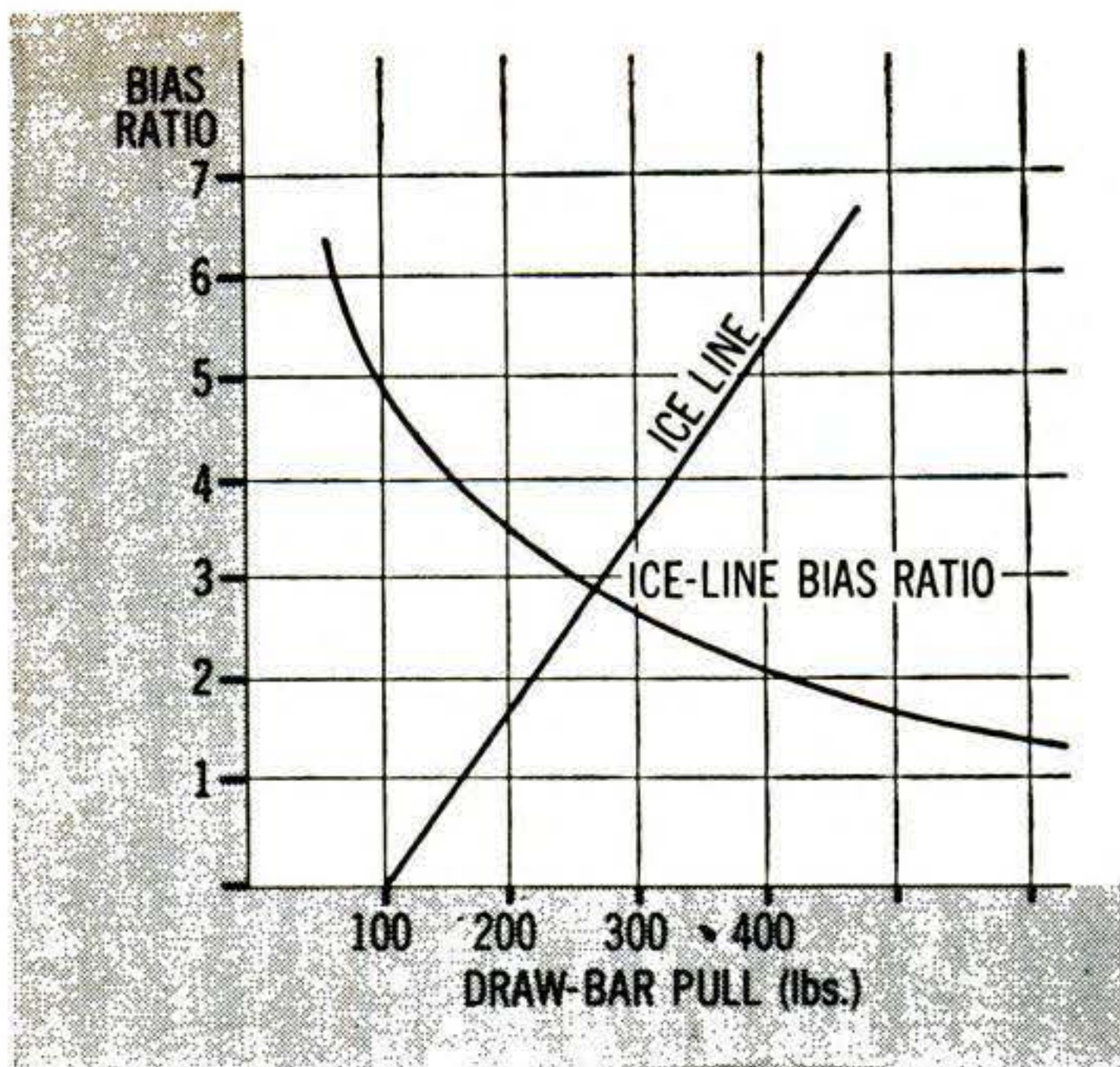
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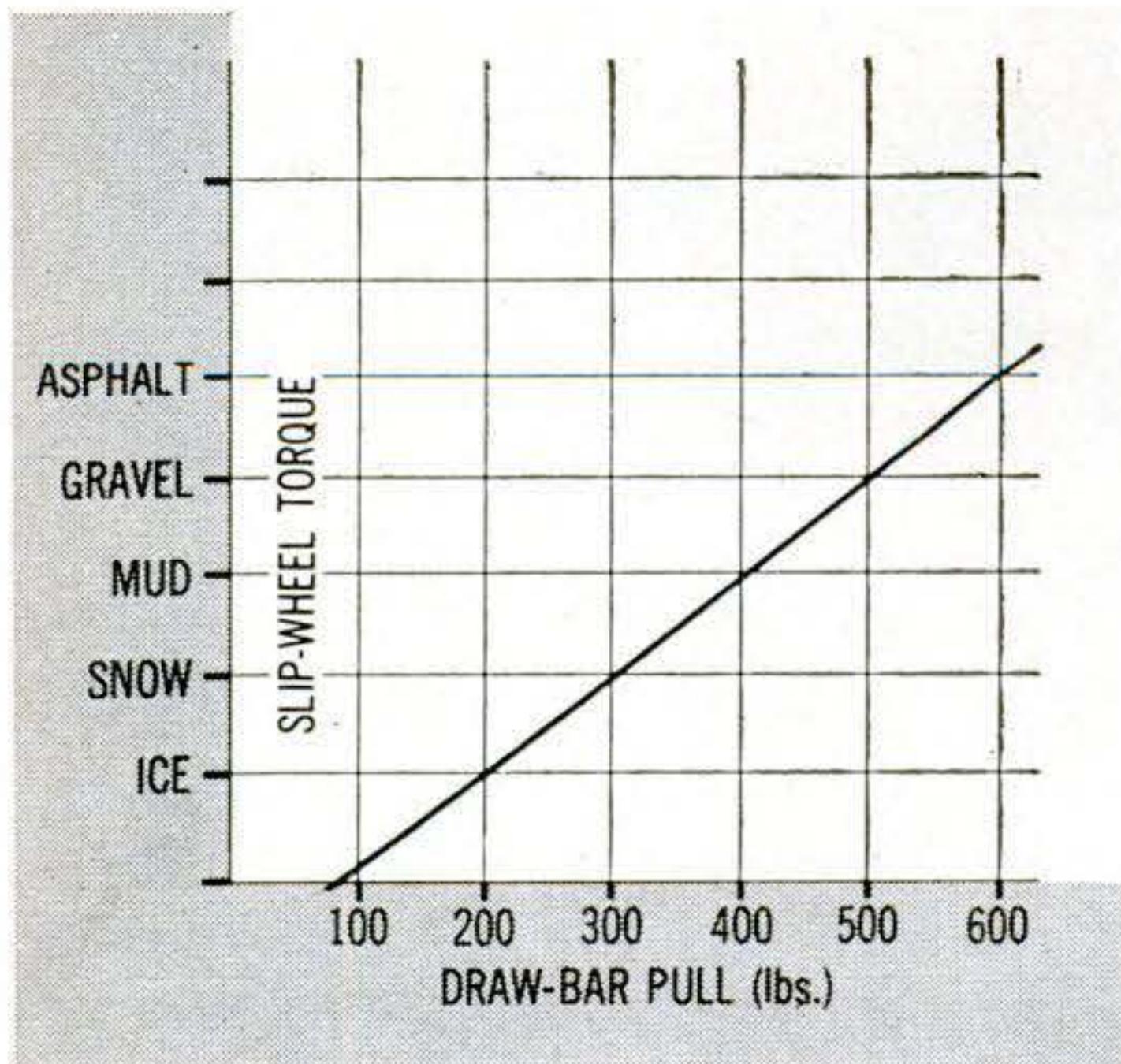
With only one rear wheel spinning on the standard-axle car, the Olds engineer couldn't push it sideways. With both wheels spinning, he did—but then the car also crept forward. The standard-axle car we tested carried brand-new tires; the car with antislip had tires bearing 1,000-mile wear.



With rear wheels spinning together, car equipped with antislip was easily pushed sideways on ice by Olds engineer. Its lateral stability at very low speed proved inferior to that of car with standard axle. Whether more directional stability under these conditions has value is, of course, questionable.



Bias ratio is torque in the gripping wheel divided by torque in slipping wheel. Drawbar pull is torque of both driving wheels combined. Ice line represents rise in drawbar pull possible with higher bias ratios. Normal ice-line bias ratio is 2.8:1.



Slip-wheel torque is an expression of the tractive force between the road surface and the tire. It is determined by the coefficient of friction; the firmer and more abrasive the road surface, the higher this torque. Drawbar pull increases in proportion.



Acceleration from standstill along the 100-foot icy stretch proved that tire tread pattern plays a bigger role than the type of differential. This may be true only for very smooth surfaces, evenly iced.

It covered the 100 feet in 10.9 seconds. The other car needed 14.8 seconds.

As long as there is traction for one rear wheel, the car with the antislip axle has a big advantage. Our tests proved that. We also proved something else: If you have only one tire chain, that's enough to get you going if you have a limited-slip differential.

We also ran acceleration tests on dry pavement. The car with antislip won. It covered the standing quarter-mile in 14.6 seconds, against 15.2 for the other. Axle tramp and wheelspin lost the race for the car with the standard axle.

Antislip drawbacks. Limited-slip differentials are accused of being noisy, of wearing out, and of causing fishtailing.

The noise complainers refer to chatter that may occur when sharp turns are made on dry pavement. Oldsmobile says this problem is not completely licked, though

Comparison of cars, pull-tested with one or both driving wheels on ice, with and without use of parking brake, is shown at right. Holding back the spinning wheel with parking brake increases the load on the multiplate clutches in antislip differential and makes possible a considerably higher drawbar pull.

DRAWBAR PULL-TEST RESULTS			
DIFFERENTIAL	WHEELS ON ICE	PARKING BRAKE	DRAWBAR PULL (pounds)
Standard	All four	Not used	100
Anti-spin	All four	Not used	180
Standard	All four	In use	150
Anti-spin	All four	In use	325
Standard	Left F&R	Not used	125
Anti-spin	Left F&R	Not used	400
Standard	Left F&R	In use	200
Anti-spin	Left F&R	In use	825



Acceleration on dry road gave the edge to the car with antislip differential. With high-powered engines, standard axles suffer from tramp and partial wheelspin for a good portion of the quarter-mile.

our test car could not be made to chatter on any surface, or on any combination of surfaces.

Olds axle engineer Ed Rosatti says chatter won't show up until after 50,000 miles. Our car was practically new. As for wearing out, all manufacturers count on at least 100,000 miles for the clutch disks.

A lot of progress has been made in lubricants in the past couple of years. Mobil came up with a better formula to prevent chatter and plate wear. It contains special friction modifiers that play up the dynamic friction in the clutches and play down the static friction.

Oldsmobile (which makes its own axles and differentials) has developed clutch disks with improved configuration and hardness. They're treated (Tufftrided) to prevent warpage in extreme heat, and have a special pattern for better lubricant retention during periods of extreme centrifugal force.

Our test car had a certain vibration, although without noise, when accelerating hard from standstill on a sharp right-hand turn.

This occurs because of torque reactions in the axle itself. The axle tries to turn around the pinion shaft, in a direction opposite to that of pinion rotation. Thus the right wheel is subject to a lifting force while the left one is pressed harder to the ground. Without antiskid, this results in wheel hop and intermittent wheel-

spin. That's because of torque reaction in the axle, which tries to lift the right wheel. As wheel lifts, it loses traction, and torque reaction is cancelled. The wheel regains traction, and cycle is repeated.

spin. The antislip unit overcomes the torque reactions, but their intermittent nature gives rise to slight vibration in the whole rear suspension.

The lateral weight transfer to the left due to centrifugal force set up by making a right-hand turn aggravates the situation. On left-hand turns, there is no vibration, mainly because the motion of the car causes a weight transfer to the right rear wheel.

What about stability? Does the antispin axle produce lateral instability on slippery roads? Our tests (see photos) proved that the standard axle offers higher stability at or near standstill. But some instability at a walking pace or even less speed would seem far preferable to not moving at all!

At higher speeds, we found the same lack of stability on both types of axles. Any lateral drift in the tail of the car seemed to come from extraneous causes—such as road camber, front-wheel steering angles, or road-surface unevenness—which had the same effect regardless of whether the car had an antislip axle or not.

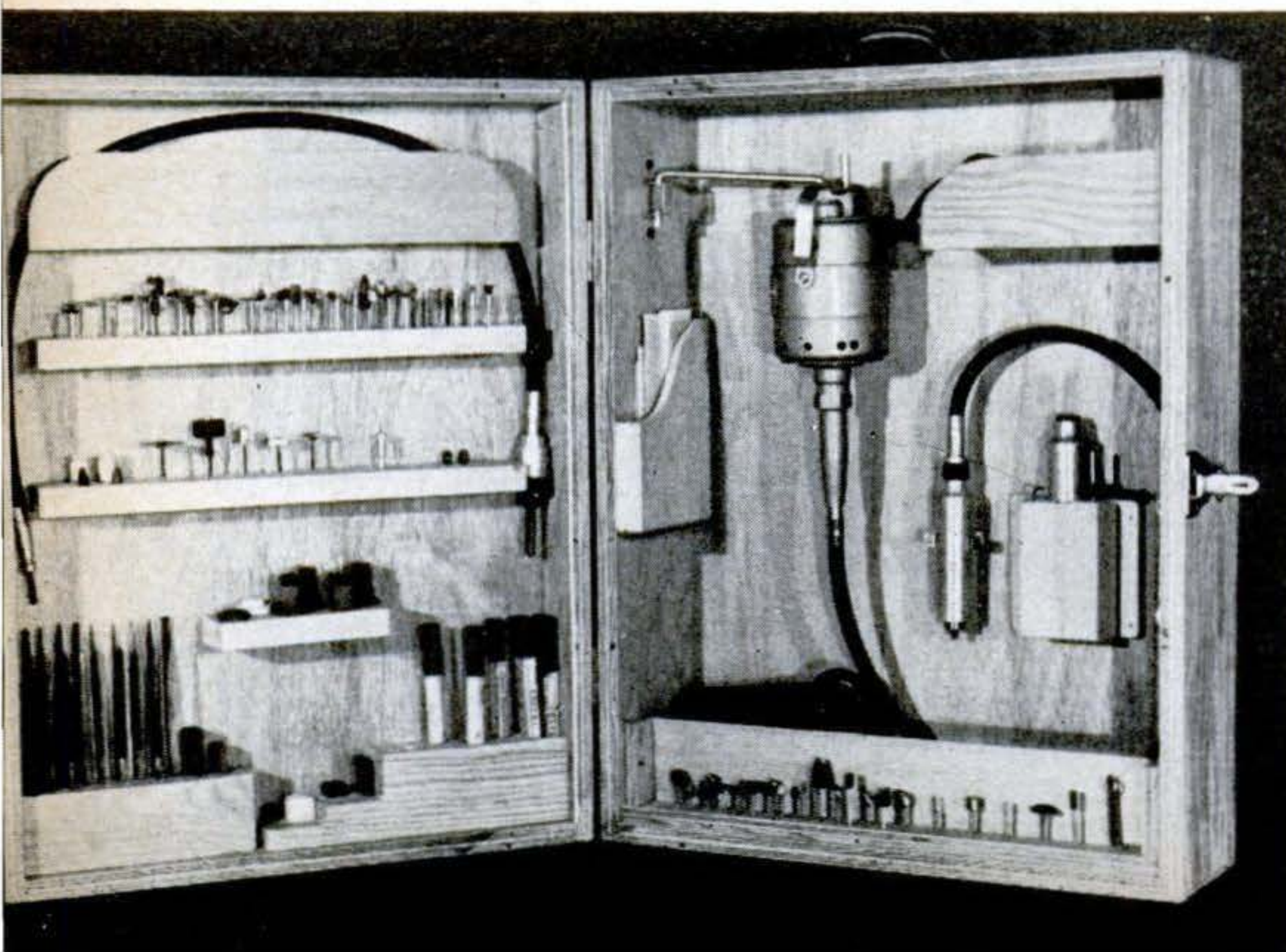
Conclusion. After these tests, we know that limited-slip differentials produce no miracles. You can be so badly stuck that they can't get you going. But do we recommend limited-slip differentials? We sure do. As a factory-installed option, they're a real bargain, ranging from \$45 to \$60, depending on make and model. **P5**



Power source for small flex shafts can be shop tools such as drill press (left) or lathe—as long as you use the highest available speed and a light touch on the work-piece. These tools—and some heavy-duty portable drills—have more torque than small shafts were designed for.

SHOP POWER AT

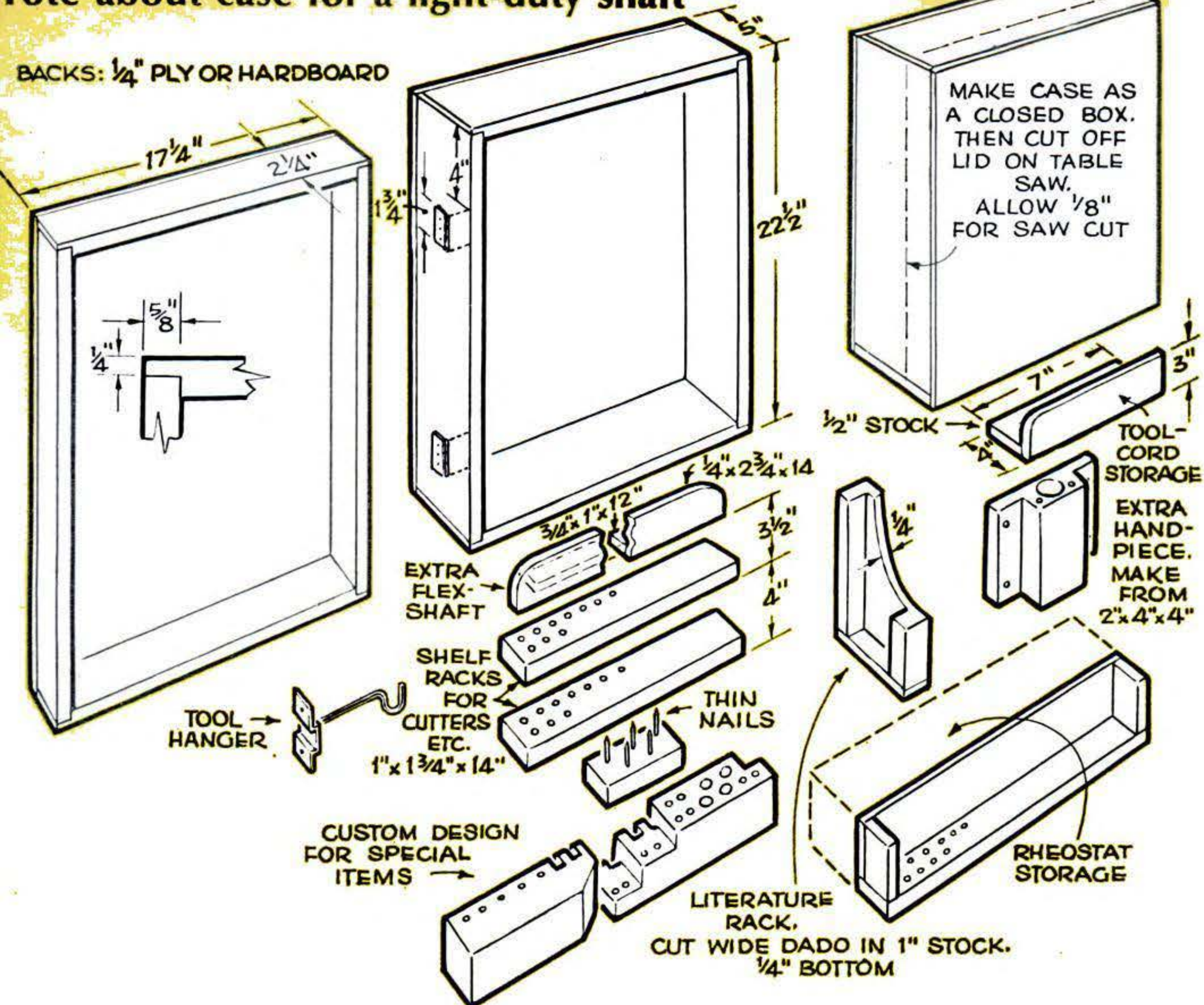
Tote-about case gives you complete flex-shaft workshop you can set up anywhere. Tool shown is from Foredom Electric—you custom-design it by choosing motor, shaft, and handpiece; it comes with the swiveling hang-up arm shown and a foot-operated carbon rheostat, costs around \$70.



The flexible shaft is a versatile tool if you know when and how to use it—and if you mount it for maximum portability

By R. J. De CRISTOFORO

Tote-about case for a light-duty shaft



YOUR FINGERTIPS

Imagine the jobs you could zip through if your fingers were a drill chuck powered by a motor in your shoulder. That's just about what a flexible shaft gives you. The torque and r.p.m. of the power source nestle in the palm of your hand, and the dexterity in your fingers, wrist, and elbow direct the power exactly where you want it. The result—when you add a few accessories (and a collection of burrs that may not cost you a cent)—is a workshop of miniature power tools for jobs ranging from finish sanding to gunsmithing.

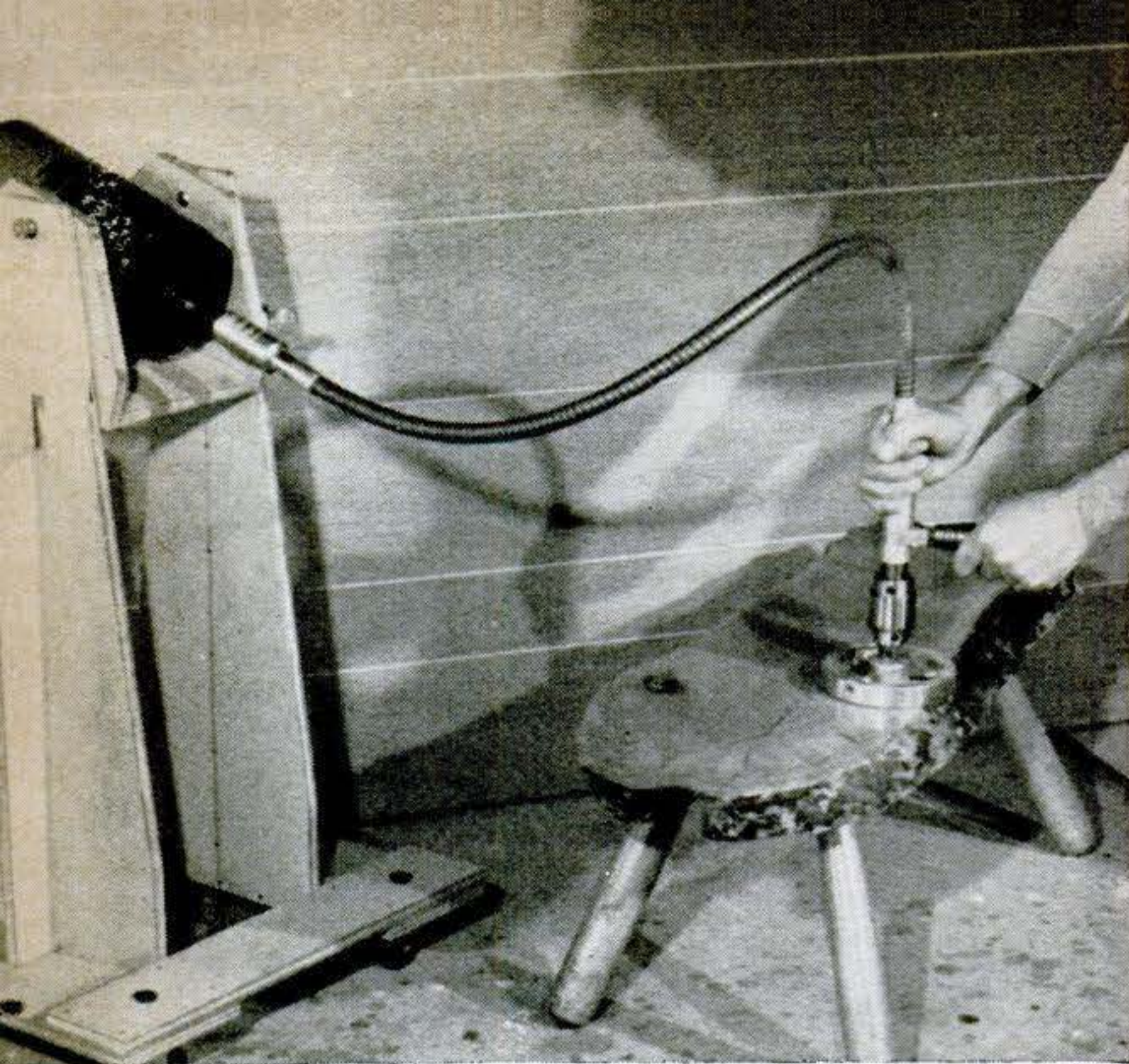
You're no longer hampered by the rigidity of a solid, straight-line shaft—as with similar accessories in a drill press.

You can use a flex shaft with the finesse of a surgeon or the muscle of a steelworker; but to do both—or either—efficiently requires a wise choice of shaft and motor.

The right core size. Jobs of delicate pre-

cision are accomplished more with speed than with power. On the other hand, chores of heavy sanding or weld grinding require husky torque more than they do speed. In general, small-core shafts are made for high speed (up to 35,000 r.p.m.) and a light touch; large-core units are for the bear-down jobs. The core size is the diameter of the shaft itself—not the casing—though it's reasonable to assume that the larger the casing, the larger the core.

To put it categorically, figure that a large core can run from about $\frac{5}{16}$ " up to $\frac{1}{2}$ ". Small-core units can start as fine as $\frac{1}{16}$ ". As far as application is concerned, make $\frac{3}{16}$ " the maximum core for jobs that require flexibility and control more than power. Next up the job ladder, a $\frac{1}{4}$ " or $\frac{5}{16}$ " shaft is fine for light-duty polishing, buffing, grinding, and so on. For jobs typified by heavy sanding and grinding,



A heavy-duty shaft is handiest if you perch it on roll-about stand

Heavy shafts can run as long as six feet, but you'll still want to roll the unit near your work. If you slot cradle as shown in alternate sketch, you can lift it from the stand for bench-top work. Material used is hardboard-covered ply. Shafts with hose-like casing are even more flexible than type shown.

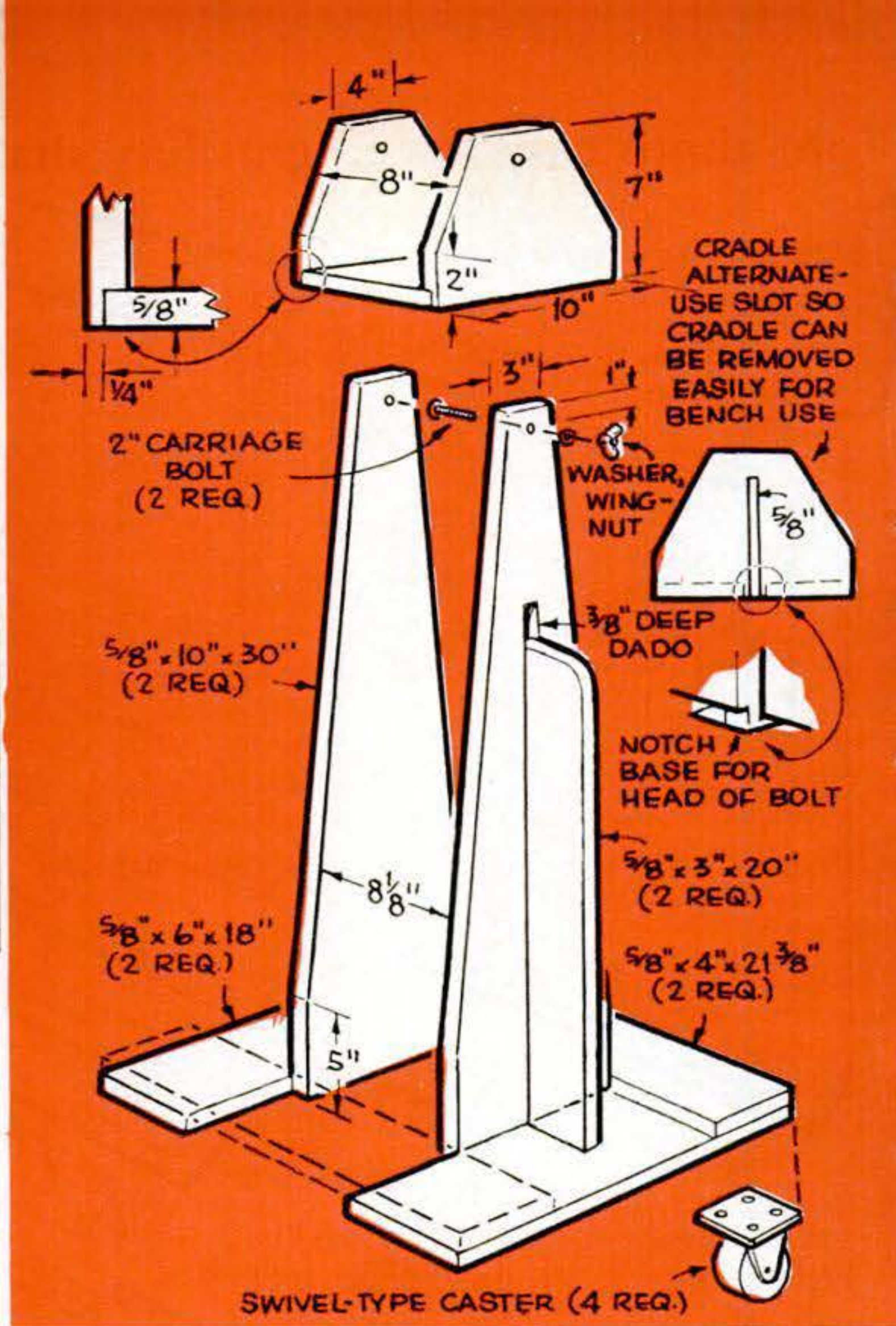
you want a core at least $\frac{3}{8}$ " in diameter.

A flexible shaft includes the core, which turns, and a casing, which doesn't. The casing can be a hose-like affair or a spirally wound steel tube that resembles armored cable. In good units, the core (whether large or small) is made up of spirally wound, directionally alternating layers of steel wire. The "pitch" of the final layer indicates the rotation direction.

The most common pitch lets you use most motors and shop tools as power sources. But since shaft cores are sometimes made with unusual pitches, check this point before you buy.

Rotation rule. Literature with the tool—

Range of sizes is indicated by typical light- and heavy-duty shafts, below. Small one relies on light touch and high speed; big one does well under heavy power, but should have an auxiliary handle.

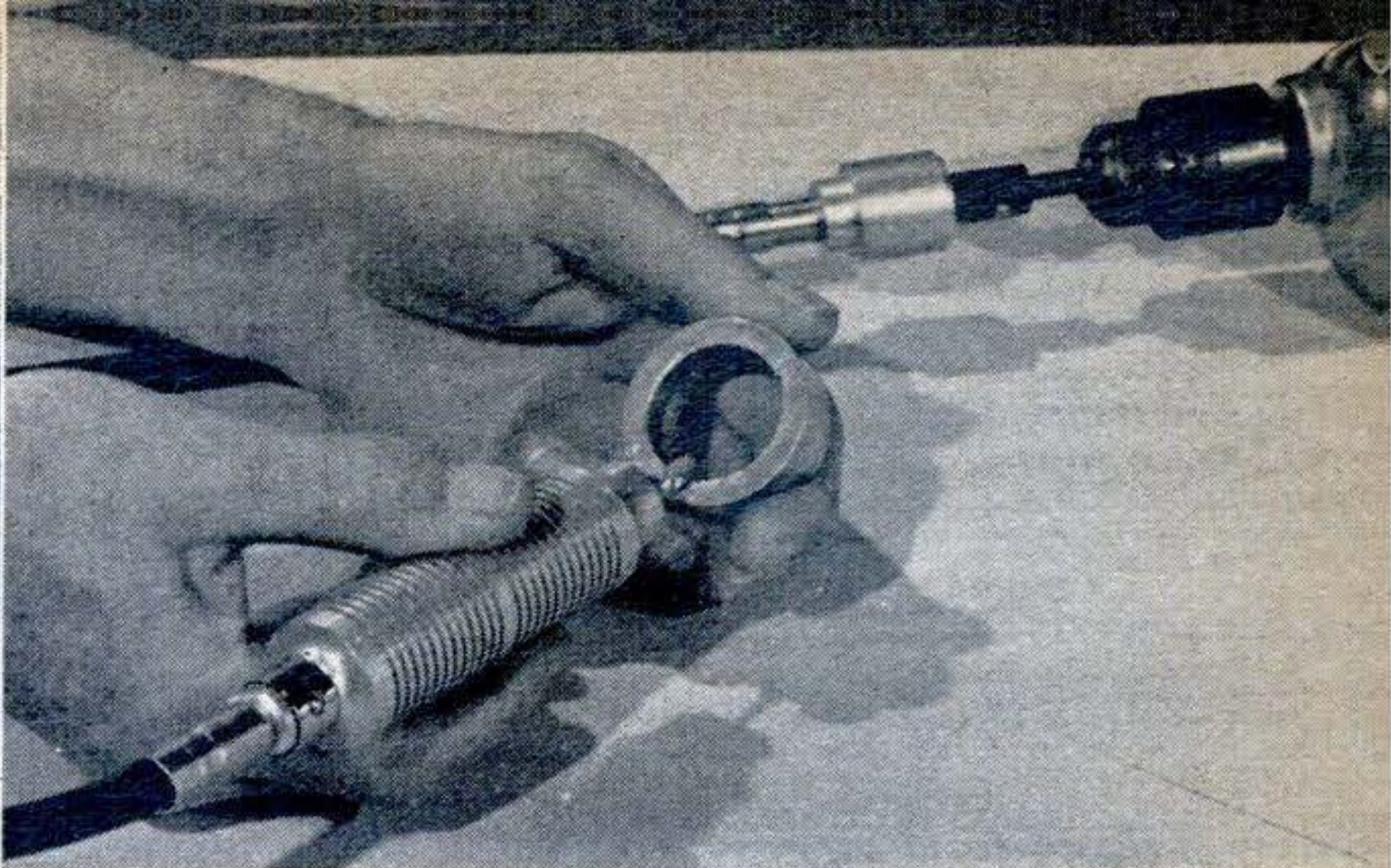
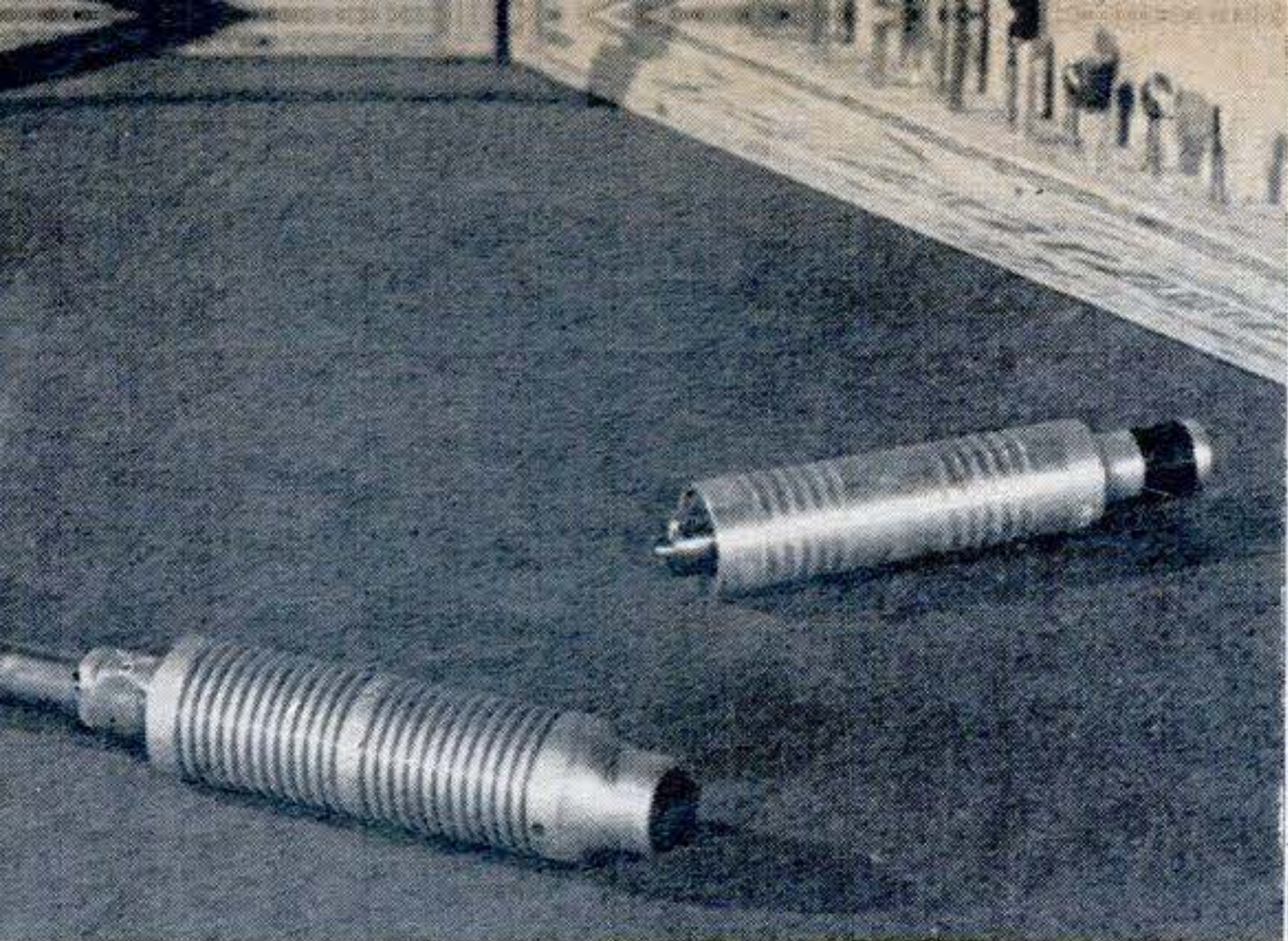


or an arrow on the casing—will tell you the correct direction of rotation. Failure to comply can result in unwinding the core wires—especially under heavy-torque conditions. It's possible to ignore the rule, but it's a very technical decision based on loading the unit to no more than half its power rating. Stick with the one-direction rule.

The coupling end of larger units is usually designed for locking directly to a motor shaft, but the size of the coupling isn't always a good indication of the power requirements. For example: a 72"-by- $\frac{1}{2}$ "-core shaft sold by Sears will fit $\frac{1}{2}$ " or $\frac{5}{8}$ " motor shafts, and has a one-hp. capaci-

Another type of tool-mount arrangement is straight shaft with a flat. On this you can mount conventional slip-on arbors like one in place here; these let you snug a nut against items with center holes.





Special handpiece more than doubles motor speed

Unique handpiece—Foredom's No. 35—contains speed-boosting mechanism that delivers $2\frac{1}{2}$ times the speed of the motor. With company's own motor, you can get up to 35,000 r.p.m., but more important

to average user is ability to increase speed of cutting tool driven with portable drill, as in right photo. Handpiece also has safety torque control: Overload it and it slips, protecting handpiece, shaft, and motor.

ty. Their 50"-by- $\frac{3}{8}$ " core will also fit $\frac{1}{2}$ " or $\frac{5}{8}$ " motor shafts, but has only a $\frac{1}{2}$ -hp. capacity. A full load from the larger motor applied to the smaller shaft could damage the tool.

Don't overload. Remember this when you drive a small shaft with drill-press or lathe power. Their torque is far beyond the capacity of the shaft. This doesn't negate their use—just don't overload at the cutting end.

The tool-mounting end of many large shafts is a straight, threaded spindle, fitted with flanges and a locking nut. This lets you mount any accessory that has a center hole. You can also buy conventional chucks that screw onto the threaded spindle so you can mount tools such as drills and drum sanders.

Use care with grinding wheels and be sure to protect yourself by adding accessory wheel-guards. These cover most of the wheel and incorporate a handle you can grip firmly. Goggles should be worn.

Although a 6" grinding wheel can be

driven by a $\frac{1}{2}$ "-core shaft, I prefer to stay with 4" wheels on any of the heavy-duty shafts. When you get down to the small shafts (say, a $\frac{1}{8}$ " core) the wheel diameter should not exceed one inch. Acceptable speeds have to do with efficiency *and* safety. A safe speed for a 6" wheel ranges from about 4,000 to 4,500 r.p.m., but, in all cases, read the instructions printed on the paper flanges attached to the wheels.

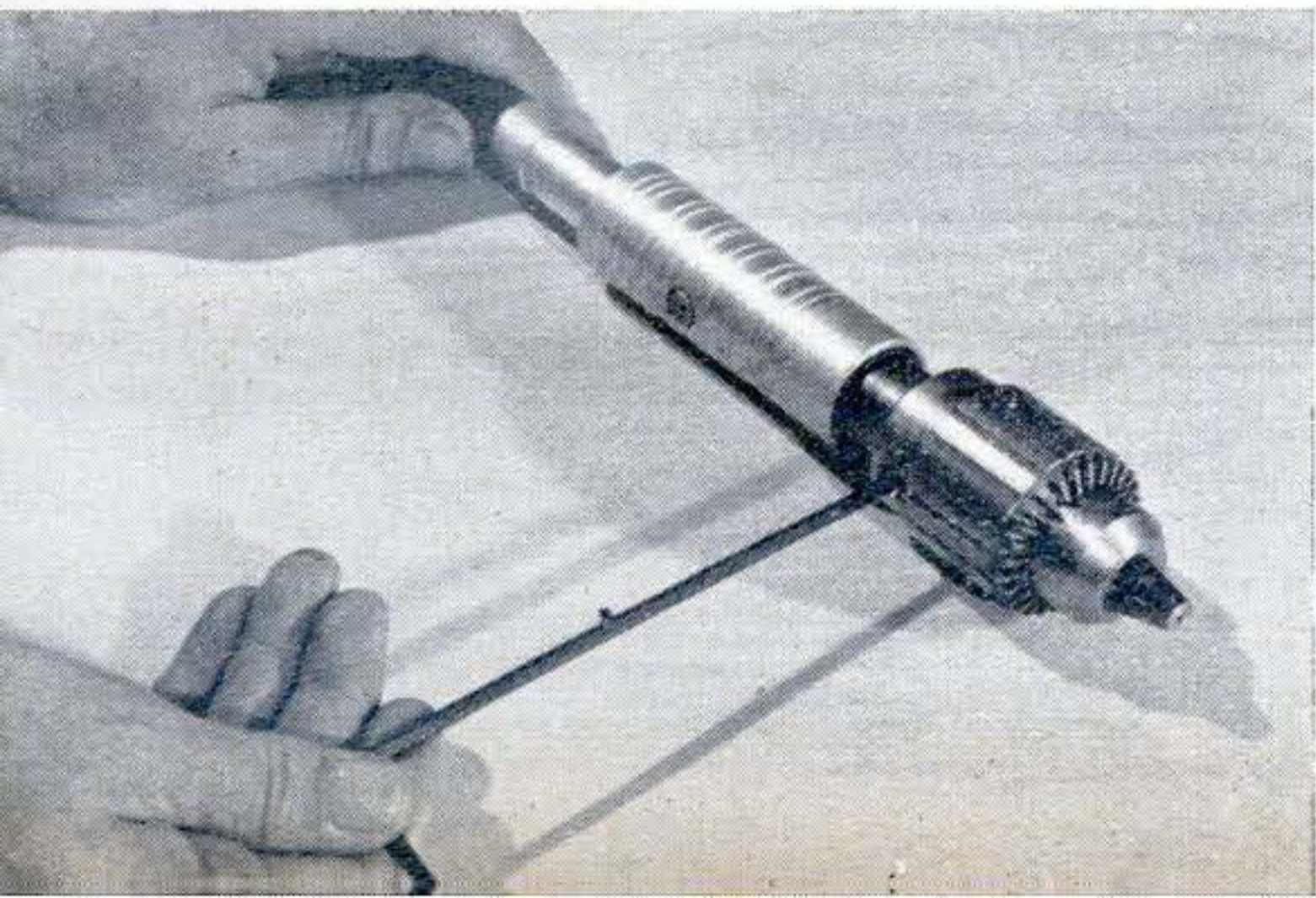
The little fellows. While many of the smaller flex-shaft machines (Foredom Electric Co., Bethel, Conn. 06801, is the major maker) are actually variable-speed tools, they'll be most valuable when used on a universal-type motor with a speed range up to 15,000 to 20,000 r.p.m. This is true even though there are applications where a slow speed is best. To give these tools a full range of uses, Foredom offers rheostats for speed control.

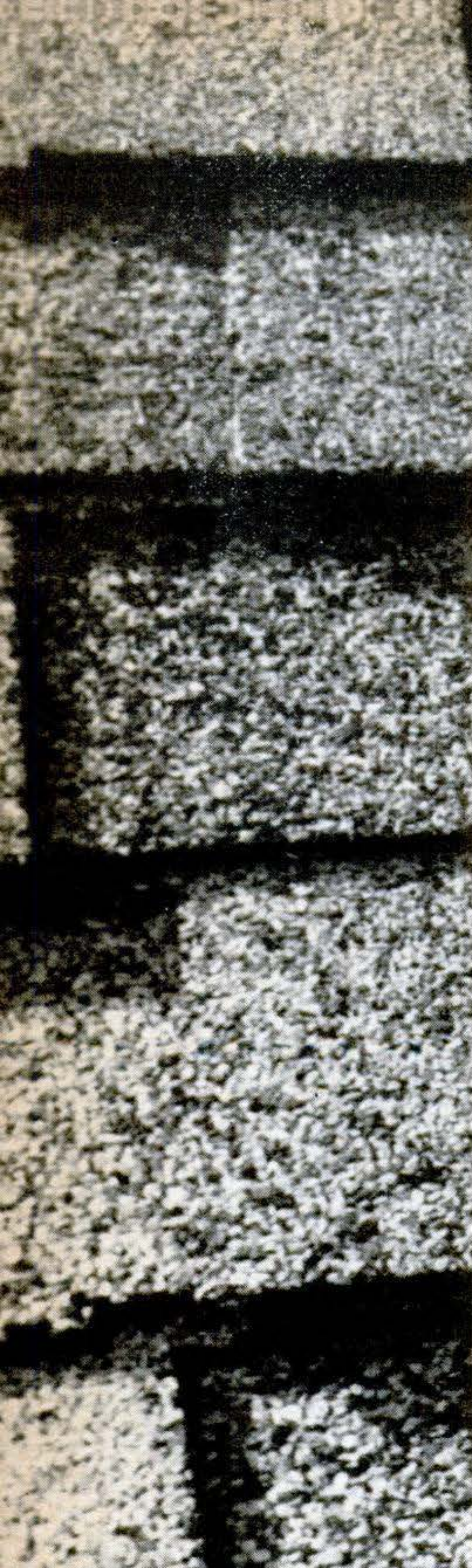
Where high speed and a light touch are needed for the job at hand, you may be disappointed if you are running the shaft

[\[Continued on page 201\]](#)

Same tool also takes three-jaw chuck that lets you use any shafted tool within its capacity: drill bits, drum sanders, sanding disks, cone-shaped wire brushes—almost anything you'd use in a drill.

Key-type chuck handpieces are available for the Foredom line of flex shafts. They'll grip anything up to $\frac{5}{32}$ " in diameter. Other types have greater capacity, but need variety of collets for full use.





NEW ROOFING: Sticks Better,

Need a new roof? Forget old concepts and check out modern materials that give you more service, safety—and beauty

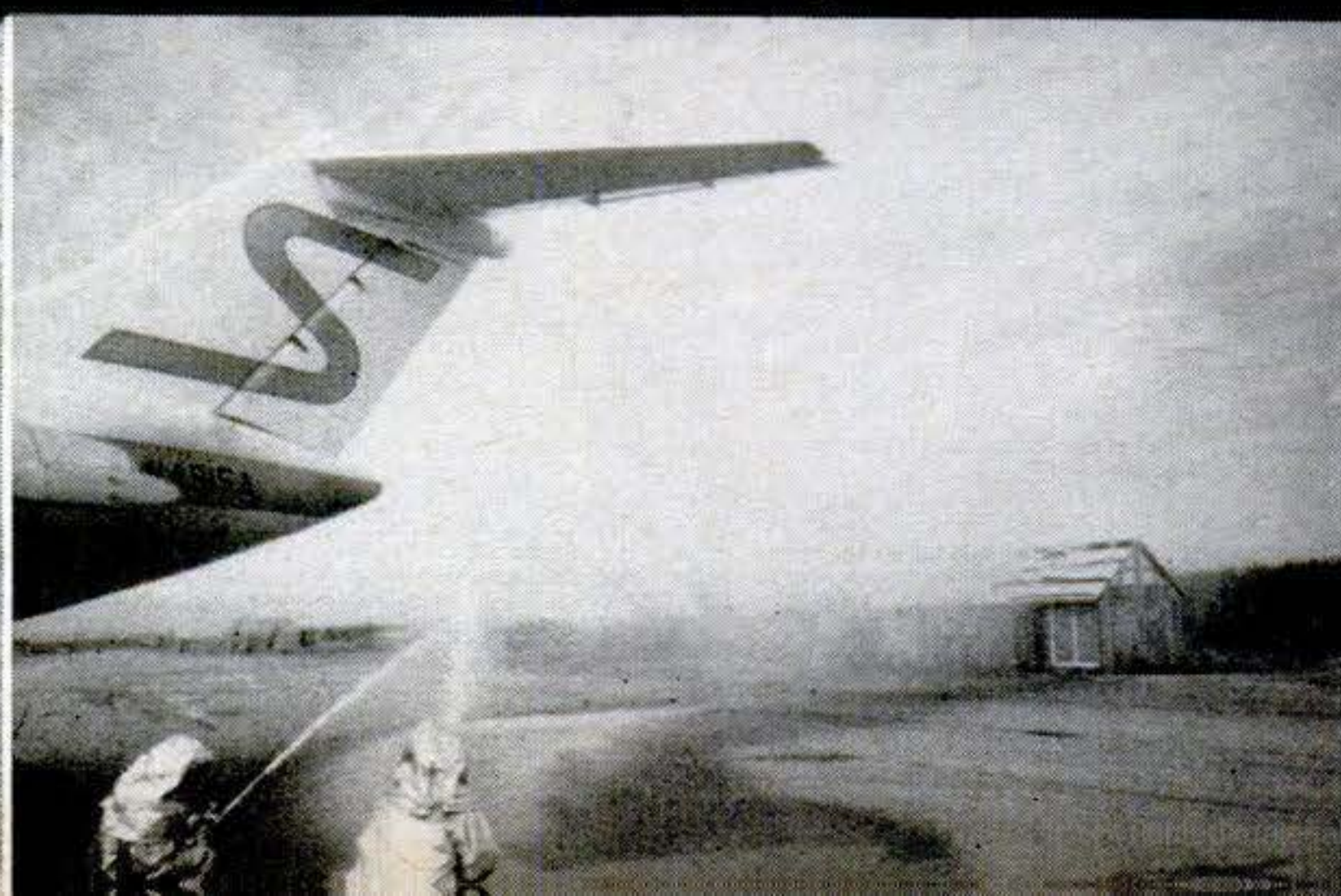
By JACKSON HAND

The next roof you put on your house—or the one you put on your next house—is going to be a lot better than anything you've had overhead to date. Research and development experts among leading roofing manufacturers have been active and productive in the past year or so, coming up with improvements in every critical area:

- You'll get longer life. Guarantees are running up to 25 to 30 years with new materials and new installation techniques.
- You'll get greater fire protection. You could build a campfire on some of the new roofing materials without endangering the house.
- Wind resistance is so much improved that one manufacturer tested his shingles by turning the blast from a jet airplane on them—along with water from firemen's hoses—without lifting a single shingle.
- You'll find new choices in colors, patterns, and textures that fit in better with today's trends toward color-scheming the entire house.

Extra eye appeal comes from strips that interlap laterally as well as in regular way. This is GAF's new Timberline shingle. Thermoplastic adhesive (note beads on back of strips, right) create welded sheet.

Space-age test of roofing was staged by Bird & Son, using DC-9 as wind, and firemen's hoses for driving rain. Left half of roof had shingles with adhesive spots (see strip at right), stayed tight.





Looks Better

● New shapes and sizes in shingling units have cut installation time, reducing labor costs if you don't tackle the job yourself.

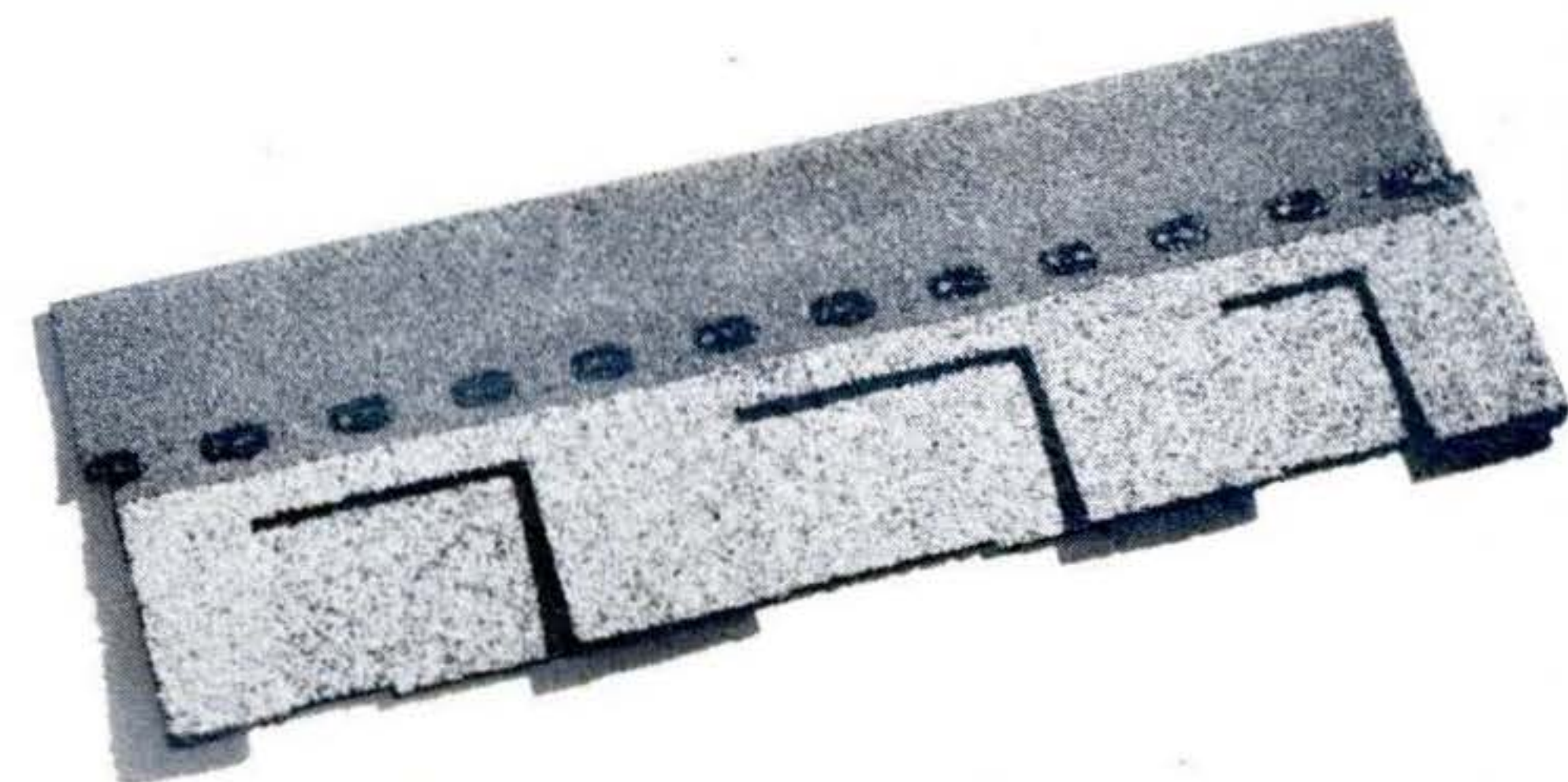
The new good looks. Over the years, what are called "asphalt shingles" have become the standard roofing for less-than-luxury homes. And they've become commonplace and banal—jazzed up a little by the addition of light colors, jazzed up further by the introduction of white, but still the same old stuff. Now and then one manufacturer or another would try a new idea, and builds—afraid of innovation and unobliged by economic conditions to give the home buyer much choice—would turn the idea down. Recently, with an increasing proportion of homes built on a custom or a semicustom basis and a decline in old-fashioned mass-produced development schemes, the home buyer has a chance to ask:

"Is there anything we can have instead of that same old roof?"

Ready and willing, the roofing manufacturers pulled some welcome changes:

Color. Red, blue, green, and white you can still get. But there is a new emphasis on subtler tones. Bird & Son is out with what they call *terracolors*—four earthy combinations. Woodtones and the colors of cedar shakes and shingles are regaining popularity. The trend is to roofs that mind their own business instead of dominating the view up and down the street.

Continued



New shake patterns put an end to monotonous roofs

Three manufacturers offer random-lap effect of cedar shakes. Pattern used as background frame for these pages (and shown as single strip, left) is Bird & Son's Architect 70. Directly above (and being installed at far left) is GAF's interlapping Timberline. Top photo shows Barrett Traditional Shake from Celotex, which adds broken butt line to double-lap effect. It comes in wood-tone and stone-tone colors.



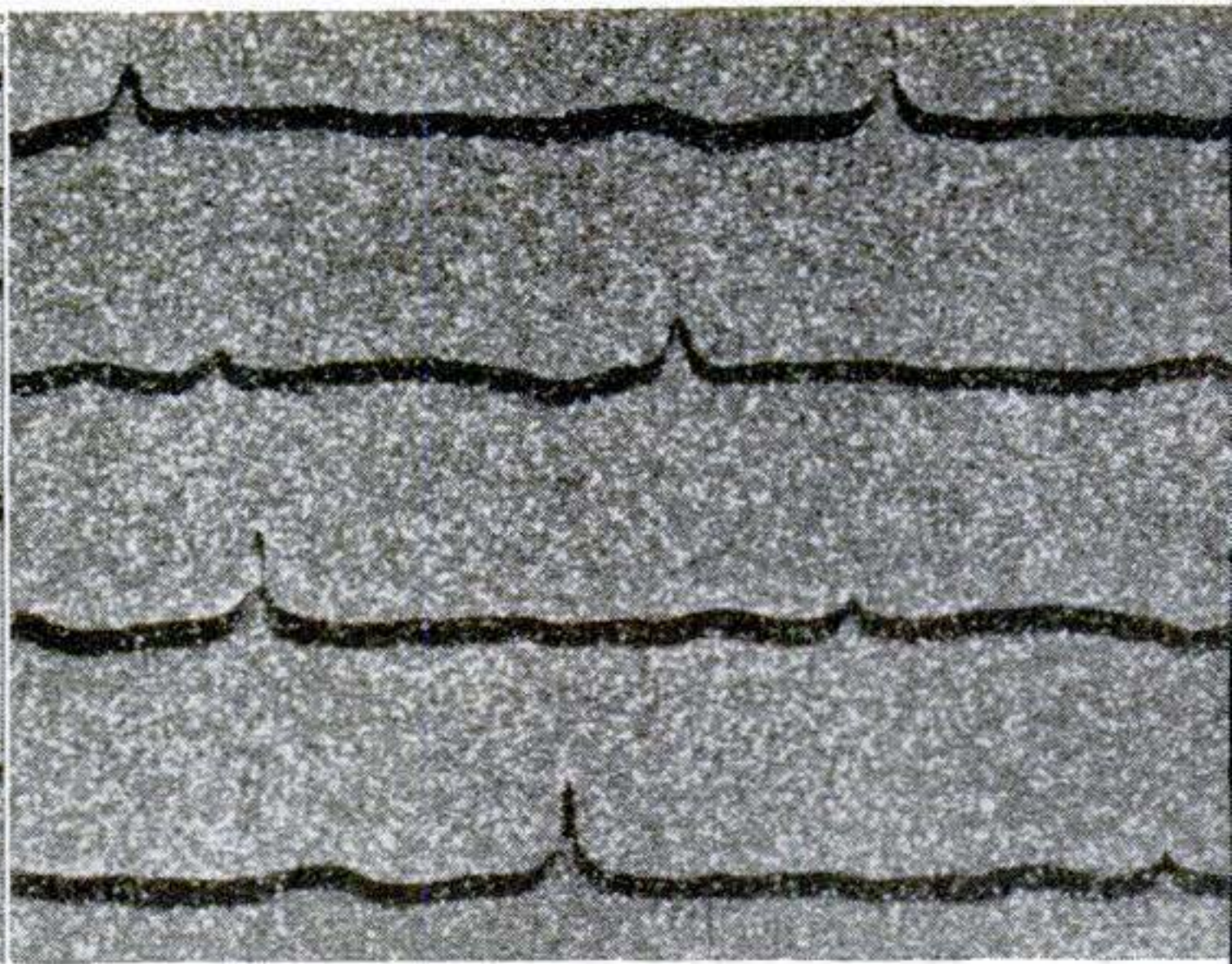
No-cutout patterns stick tighter—and fool the eye



Scored shingles look like separate pieces, are really no-cutout strips for better weather and wind resistance. Available from Bird & Son in 238-pound material, they've thicker butt for dramatic shadow line.

Shape. A second factor of importance in giving you a roof that doesn't look dull is shingle shape. We've had many years of absolute uniformity—rows of shingles exactly the same width, same spacing, same reveal. Now the repeat characteristic is being challenged by random widths. (Actually, they are not random, but the repeats are far enough apart so that they seem hit-or-miss.) GAF has a version called Timberline in which strips interlap with each other to

Want a "glass" shingle? New roofing is actually foamed ceramic tabs bonded to asphalt strips. These are applied in normal way (inset sketch) except that rabbeted inch-thick butts set into sealant bead.



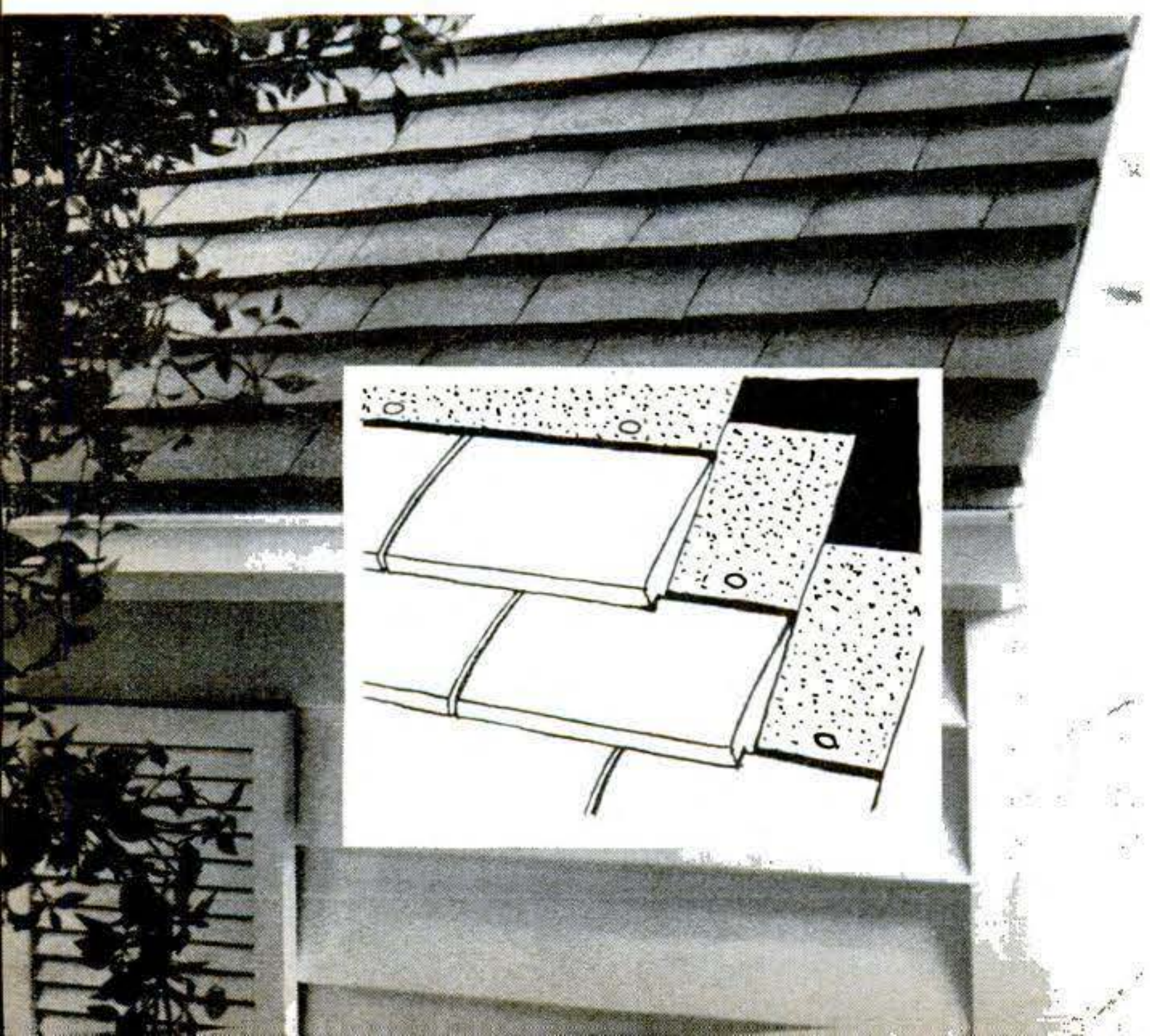
Curving edge and deep notches give Johns-Manville's Townsend shingles the look of flapped strips, but this, too, is a no-cutout pattern. It's one of the J-M shingles using both asbestos and fiberglass.

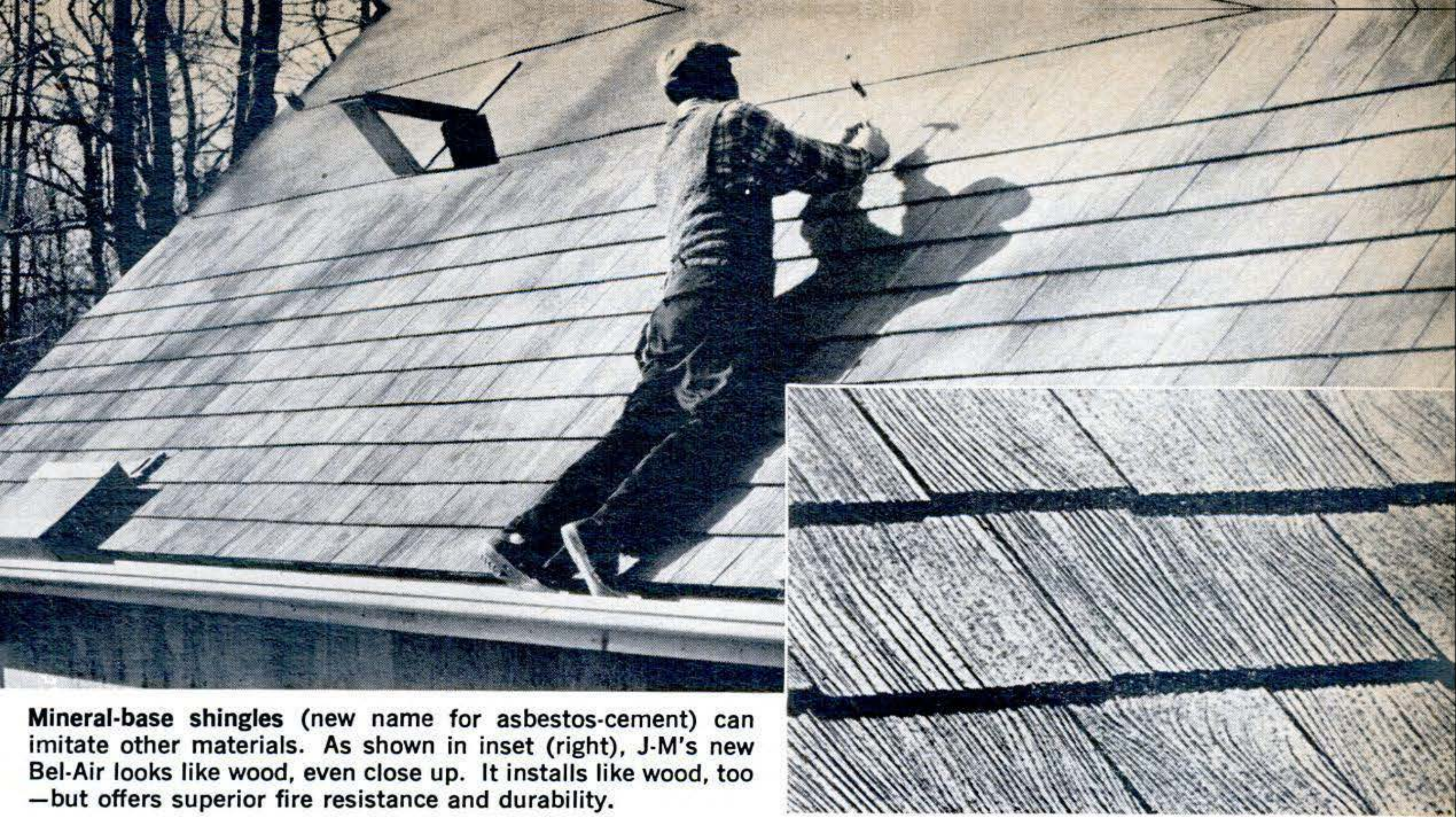
provide an over-and-under appearance with shadow cast both below the butts and to the sides of individual flaps.

Bird & Son's Architect 70 offers a similar look. Each strip is 12 by 36½ inches, with a five-inch exposed surface and a two-inch headlap. There are about 80 shingles (five bundles) to the square (a roofer's term for 100 sq. ft.) at a weight of 345 pounds.

The Townsend shingle from Johns-Manville is an example of die-cut pattern along the butt edge. Although this is a no-slot shingle, the pattern gives the appearance of individual shingles. Bird & Son is putting heavy emphasis on the "no cutout" shingle which has embossments at random intervals to give the look of shingles.

Wind resistance. They're offering shingles now with a guarantee of five years without damage from the wind. The new wind resistance is due largely to two factors. The first is improvement in the thermoplastic "dots" beneath the butt edges of the shingles, and the use of thermoplastic materials in the body of the shingles, as well. In some brands, there is a double row of dots, one at the edge and one about halfway up the strip. What these thermoplastic materials do, in simple terms, is soften or melt under the heat of the sun, cementing each row of shingles to the one beneath it. (Actually, all it takes is a warm day to do the





Mineral-base shingles (new name for asbestos-cement) can imitate other materials. As shown in inset (right), J-M's new Bel-Air looks like wood, even close up. It installs like wood, too—but offers superior fire resistance and durability.

thermal job, in case you're wondering about north-oriented or heavily shaded roof surfaces.) Once these materials have gone through the soften-harden cycle, they tend to stabilize, providing adhesion too tough for the wind to disrupt.

The second factor is edge design. Several manufacturers have had a roofing material with no cutout whatever in the heavier grades. New at Bird & Son is a no-cutout shingle in the lighter-weight, more economical 235-pound class. Since there are no flaps to blow loose, wind damage is reduced. U.S. Gypsum is one manufacturer that makes heavy-duty strip shingles with only two big flaps per strip, plus double thermoplastic dots.

When the bottom layer of asphalt contains thermoplastics, these factors combine to give your house a roof that is practically a solid sheet, highly resistant to wind and to moisture, too. (Five-year guarantees are, in some cases, for replacement of materials only, and may be prorated according to years of service before damage.)

Fire resistance. Traditionally, roofing materials have been made of asphalt-impregnated felt, topped with mineral granules. The felt is, by whatever name, paper—that is, made of cellulose fibers from one source or another.

In development of more fire-resistant roofing materials, first the felt was bolstered by the inclusion of asbestos fibers.

In some cases, the felt was almost entirely eliminated. The newest step, introduced by Johns-Manville, is a shingle with asbestos fibers *and* glass fibers—and no felt. In this shingle, the bulk, and therefore the amount of asphalt, has increased—boosting the weather resistance of the product as well as its fire resistance. The rating is A. (J-M also uses the asbestos-fiberglass combination in a roll roofing intended for low-pitch residential roofs, with a B rating.)

Until recently, the only way you could get a rating of B or better was to go up in weight—and thus up in cost. U.S. Gypsum, for example, has A ratings in shingles at 220, 240, and 295 pounds.

These fire-resistance ratings are established by Underwriters Laboratories with a series of tests in which a section of typical roof is subjected to three types of burning. The A label indicates maximum fire safety for roofing in high-fire-hazard industrial areas. Most codes okay a C-rated material for residential neighborhoods.

The great imitators. The other man-made shingle, mineral-base (it used to be called asbestos-cement), continues to make news through its ability to imitate other materials while adding its excellent wear-wind-fire resistance to a house.

Of the various quarry imitations, Johns-Manville's Colorbestos slates may be

[\[Continued on page 227\]](#)

SNOWMOBILES Come to the Suburbs

No space to enjoy one?
Then trailer or truck it
to areas where you can

By ROBERT P. STEVENSON

My first experience with snowmobiles came in the North Woods. I had gone to Rhinelander, Wis., as the guest of one of the manufacturers. There, for a full weekend, we ran snowmobiles around a track, across a nearby lake, and for miles on trails through the surrounding woods.

Back home, my enthusiasm spread to my sons. Could we get a snowmobile? When? Why not? But where, I asked, would we use it?

We live in a suburban area of Northern New Jersey—about the same latitude as New York City. In some recent winters we have had little snow. Houses sit along the street on each side of mine. We have no access to woodland trails. Road use is

out; New Jersey doesn't license snowmobiles. All of these facts seemed to work against a snowmobile.

But I do own nearly an acre of level land at the rear of my house. That acre certainly would let us use the machine. But what about other suburbanites, who live on typical small lots? Could they, too, join in this enjoyable winter sport?

A manufacturer agreed it would be worth finding out, and I arranged to borrow a machine for the season.

Neighbors had them. The dealer who brought it delivered some news as well. No, my snowmobile was not the only one in the neighborhood. Yes, some of my not-too-distant neighbors had them. In fact, one family had just bought the third snowmobile in as many winters, trading up for a better one each season.

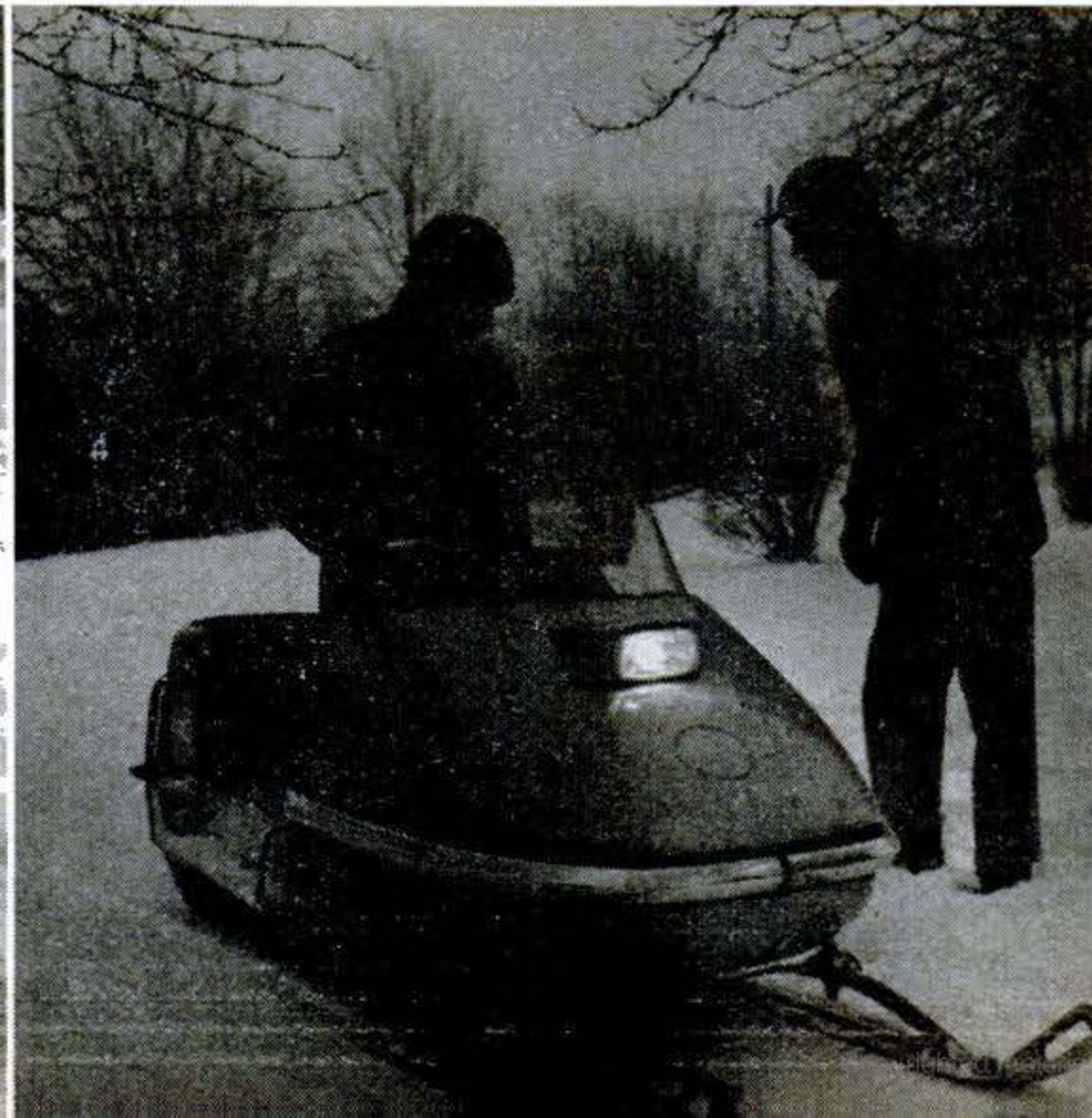
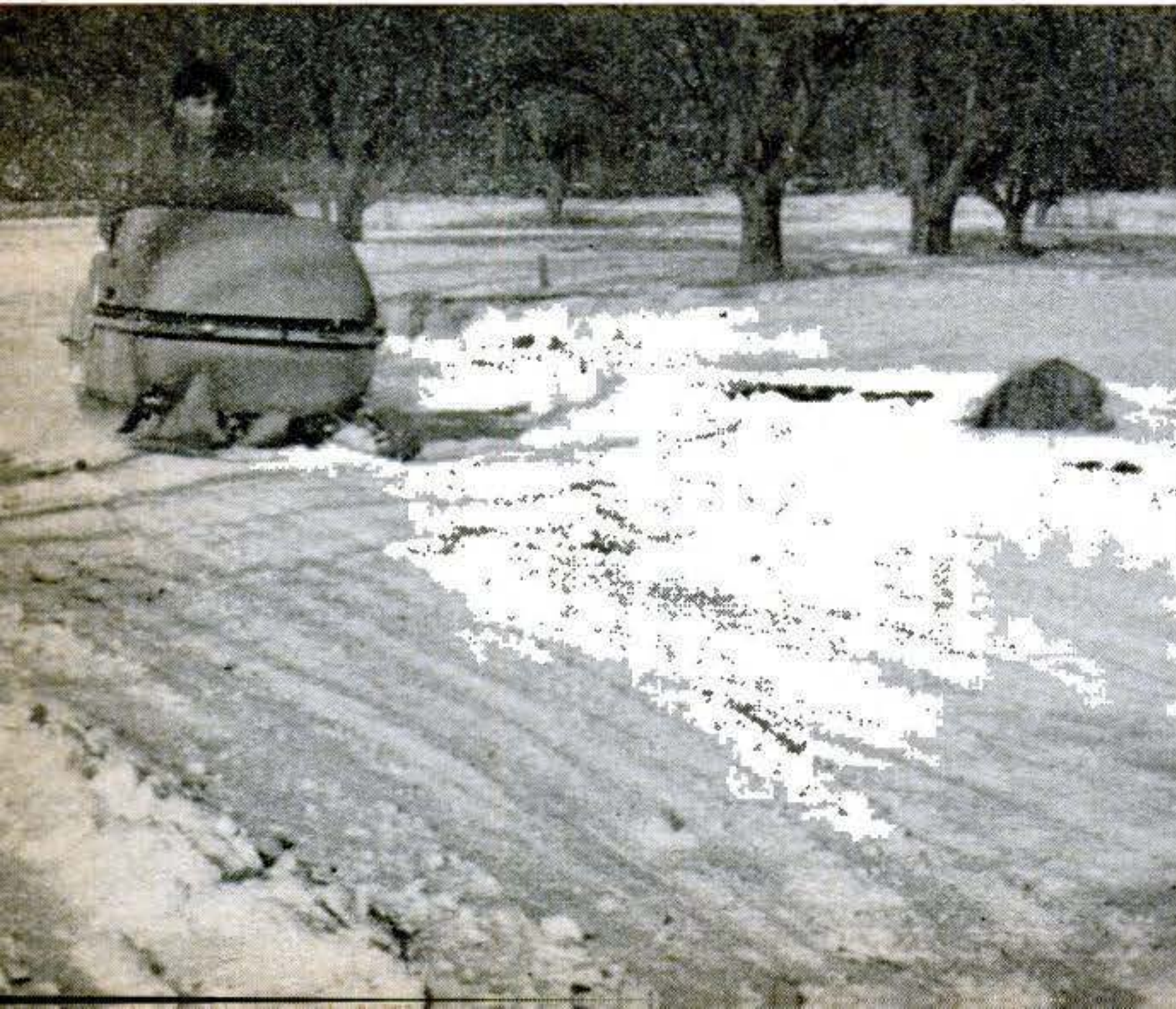
Through delivery delay the first snow of the season already had come and gone before we had the machine. We had nothing but bare ground for miles around.

This renewed one of my original doubts. To find snow, would I have to set off for

Continued

John speeds down the straightaway of the track the boys marked out on a neighbor's land. A sweep-second hand on wristwatch was used to time circuits.

A good headlamp on our Nordic Ski-Doo let us enjoy the machine at night. That's when adults are likely to take over—after the kids have gone to bed.

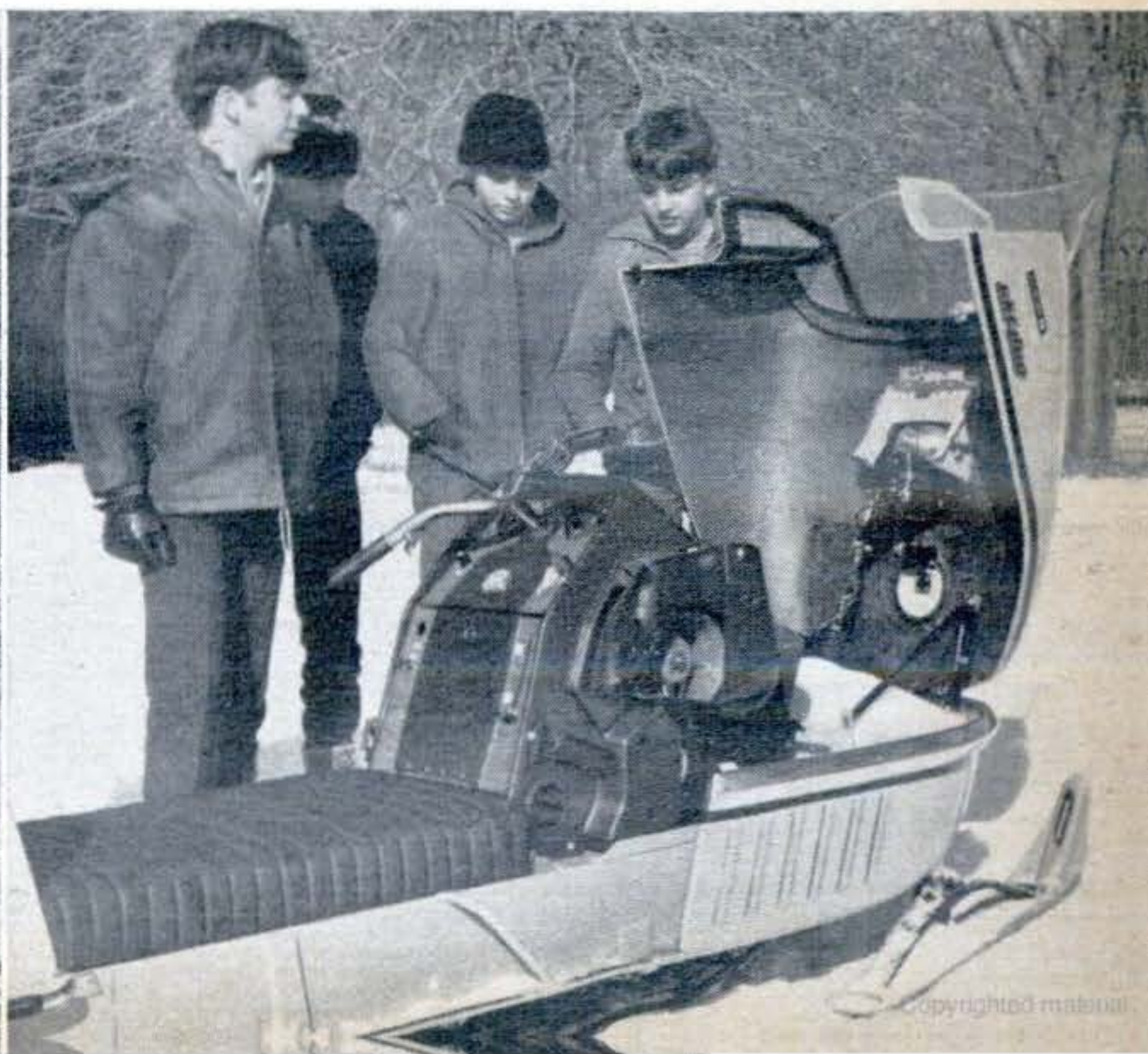




A pickup owned as the family's second car is ideal for snowmobile transport. Here, willing hands make quick work of loading during storm. Usually you can ride one up the ramp.

Peter and his pals, Scott and Bill, sometimes piled on together for a whirl around the track, but more often than not one hopped on as another hopped off.

What's under the hood? Just about everyone wanted a look at the engine and its accessories. The fuel tank is located there, too, in the Nordic Ski-Doo.





Jockey John strikes the position he preferred for roaring around the oval track that he and some of the other boys marked out in a neighbor's apple orchard. Pros, of course, ride with one knee resting on the seat cushion.

a weekend, and trailer it northward? This is always possible; in fact many people do it, as I eventually learned. This question of snow or no-snow faces many others in a fairly wide snow fringe across the U.S.

came, some invited, some not. After the plows had cleared the roads, spectators slowed up to watch. Some parked. The mailman delivering a package took time to accept a ride and then, after the simple

Some years the edge of the belt extends disappointingly far north.

Snowmobile makers have promoted an appropriate slogan: "Think Snow." I told my sons about this. I suggested they "think." They obviously did. Early in February snow began. It fell all day. It fell all night. Fourteen inches or more piled up for us.

On the Stevenson acre it brought no trouble at all, just fun. The snowmobile began to run. It ran and ran. Neighbors

Your SNOWMOBILE

Do you need a driver's license to operate your new snowmobile? Does it have to be registered in your state? And where can you legally drive it?

Unfortunately, there are no across-the-board answers to these vital questions on our fastest-growing vehicle sport. With snowmobiles scooting smoothly into their second decade, a mass of confusing laws and red tape complicates their legal status and operation in many states. Two exceptions are Maine and Minnesota, which have adopted nearly model laws governing snowmobiles. That's because they treat the snowmobile as a recreational vehicle, not as a freak motorcar.

Except for the requirement in every state that snowmobiles be equipped with lights and brakes (already standard on every manufactured snowmobile), there are no universal regulations covering these vehicles. In fact, because of varying classifications, even the agency with

jurisdiction differs from state to state. California, Massachusetts, New York, North Dakota, and Ohio still classify snowmobiles as motor vehicles.

Here are the principal regulations of the states where the rigs are most used, based on a survey made by the International Snowmobile Industry Association:

You must register your snowmobile in practically all snow states except California, Colorado, Oregon, Iowa, and Wisconsin. Fees range from less than \$3 a year to a high of \$10 a year in Maine.

You need a driver's license (automobile) to operate a snowmobile in Ohio at all times, and in Idaho, New Hampshire, and New York, you can't cross a road on a snowmobile unless you hold a driver's license. No driver's license is required by other states.

You can't legally drive on roads in most states, but you can cross streets and highways. Before crossing, you are re-

instructions that are necessary, he took the machine around the yard himself.

With this much experience, my boys began to yearn for wider fields, literally. They arranged with the owner of an adjoining apple orchard to take the snowmobile there. They quickly marked out an oval track nearly a quarter mile around.

There, on one Saturday—from 9:30 in the morning until 10 at night—the machine stopped only long enough for drivers to switch. That day, if you're interested in such statistics, the motor consumed about four gallons of regular gasoline, spiked with oil, of course, as is the need of two-cycle engines. For the enjoyment returned, that expenditure (I figured) was downright minimal.

It was interesting to watch the style of different operators. As a group, oldsters were slow on the turns and moderate on the straightaways. The youngsters, those below 10, were cautious, too—and I wouldn't have it any other way. But they all enjoyed their first chance to operate a motor-propelled vehicle.

The teen-agers went for speed. Sometimes too much for safety. My 17-year-

old John led the way. It was he who, on the quarter-mile track, first achieved the general teen objective "to floor it." Actually, this can be done safely. The machine we used has a good brake (on the outer rim of the big drive pulley), and it's possible to cut speed quickly to turn.

Of all those I watched, I'd say that 14-year-old Peter's peers got the greatest satisfaction from the machine. Boys of this age have intense automotive interest, but are forbidden by law to drive. They can find a satisfactory substitute in a snowmobile. Peter and his friends quickly converted the quarter-mile oval into a satisfactory race track.

All of this enjoyment of the snowmobile at or near home was fine, but I still had not learned what I had set out to learn—whether the true suburbanite, with the smallest of yards, can justify the expenditure of \$1,000 or more for a snowmobile.

Obviously, with no place at home to use it, the suburbanite must prepare to transport the machine to a region where he can. This is precisely the situation a suburbanite faces in buying and using a boat, even

Continued

and the Law

quired to come to a full stop and yield to all oncoming motor vehicles.

You can ride in many state parks on snowmobiles. They're permitted in Maine, Minnesota, Montana, New Hampshire, North Dakota, and Wisconsin. Some of these states have marked trails.

You must have permission of owners, obviously, to drive across farms or other privately owned land.

You can go ahunting with a snowmobile. But you can use it only to get to where you want to hunt (or fish). Most states prohibit the use of the vehicle for chasing wild game, or any animals.

You must file accident reports in about half the states with snowmobile laws. And reckless driving and driving while drunk are specifically prohibited by most states.

Your youngsters, when using the family snowmobile, are subject to minimum-age restrictions in several states, especially when crossing highways. In

Wisconsin the legal age is 12. It's 14 in Maine, Massachusetts, and Minnesota. In New Hampshire, Oregon, Pennsylvania, and Vermont, 16 is the minimum age.

You are legally responsible for damage to persons or property caused by your snowmobile. Although it's not required, you'd be wise to have liability insurance.

Snowmobiles, because they are so new on the scene, have presented the states with a golden opportunity to pass snowmobile laws that are free of the confusion typical of automobile legislation.

If your state has not enacted such a law, write to the International Snowmobile Industry Assn. (5100 Edina Industrial Blvd., Minneapolis 55435) for information on what such legislation should include. Then urge your state legislature to consider those proposals in framing good snowmobile laws. It's not too late for you to work for the enactment of safe and sane snowmobile legislation if you want to enjoy this exhilarating winter sport unhampered by unreasonable laws. —Herbert Shuldiner.

a dinghy or canoe. You can trailer either a boat or a snowmobile. If you already own a summer home, on a lake or stream, you're a live prospect for a snowmobile. Snowmobiles are great on ice.

At a cost of \$200 or so, I question, however, whether a trailer is always the best means of transport. Why not a pickup? A pickup owned as the family's second car—if you're that fortunate.

If I buy my own snowmobile, that's the route I intend to take—and I'm under considerable family pressure, now that my "freeload-

Snowmobiles have practical uses, too, as the newspaper clipping at right shows. The doctor traveled five-and-one-half miles to reach a patient. He owns a snowmobile primarily for his family's pleasure.

ing" period for using one has passed.

My personal choice would be either Ford's Ranchero or Chevy's El Camino. This choice would give me a passenger-car ride on my trip to the commuter station or shopping centers as well as the facility to haul those bulky or heavy items for which the family car isn't ideal.

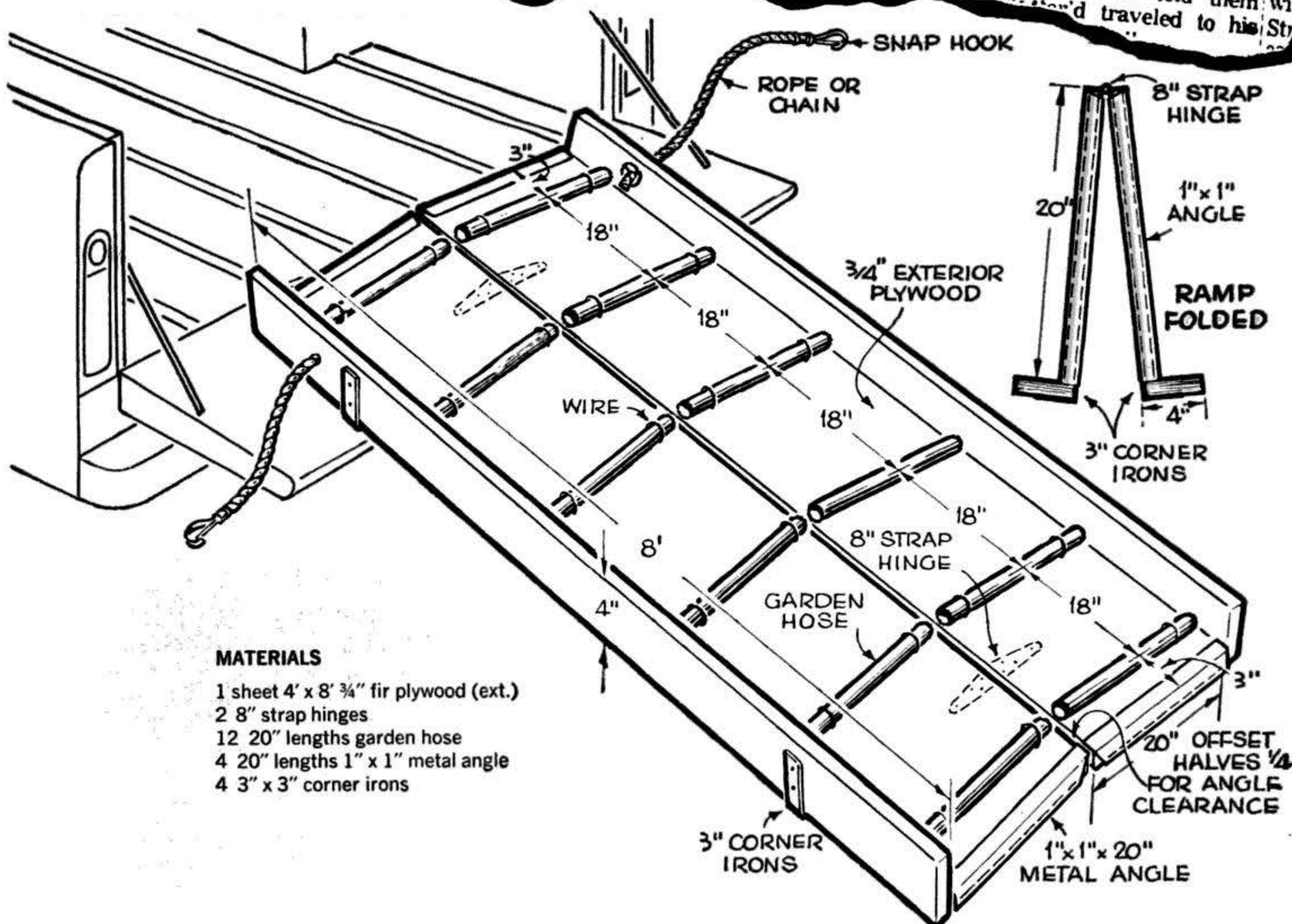
[Continued on page 194]

Snowmobile Takes Dr. Looloian Through Drifts For House Call

Probably not many physicians these days would make house calls in the middle of a snowstorm. But a Dr. M. V. Looloian in Whitehouse Station went to a patient's home on a snowmobile Sunday afternoon.

"He just put his instrument worse than this one. When the patient told the people at work that he'd persuaded a doctor to come and see him during the storm, no one believed him.

"But they really thought he'd traveled to his Str...



MATERIALS

- 1 sheet 4' x 8' 3/4" fir plywood (ext.)
- 2 8" strap hinges
- 12 20" lengths garden hose
- 4 20" lengths 1" x 1" metal angle
- 4 3" x 3" corner irons

Folding plywood ramp eases snowmobile transport in a pickup, makes loading and unloading a one-man job. To make it, saw two 4" strips off lengthwise edge of 4'-by-8' panel, cut remainder in half, and assemble as shown in sketch. Metal angles provide

stiffening at top and bottom, project about 1/4" to anchor ramp to ground and to truck bed. For extra anchorage, add chain or rope for attaching upper end to truck. Wire on lengths of old garden hose, or screw on wooden cleats to improve traction in snow.



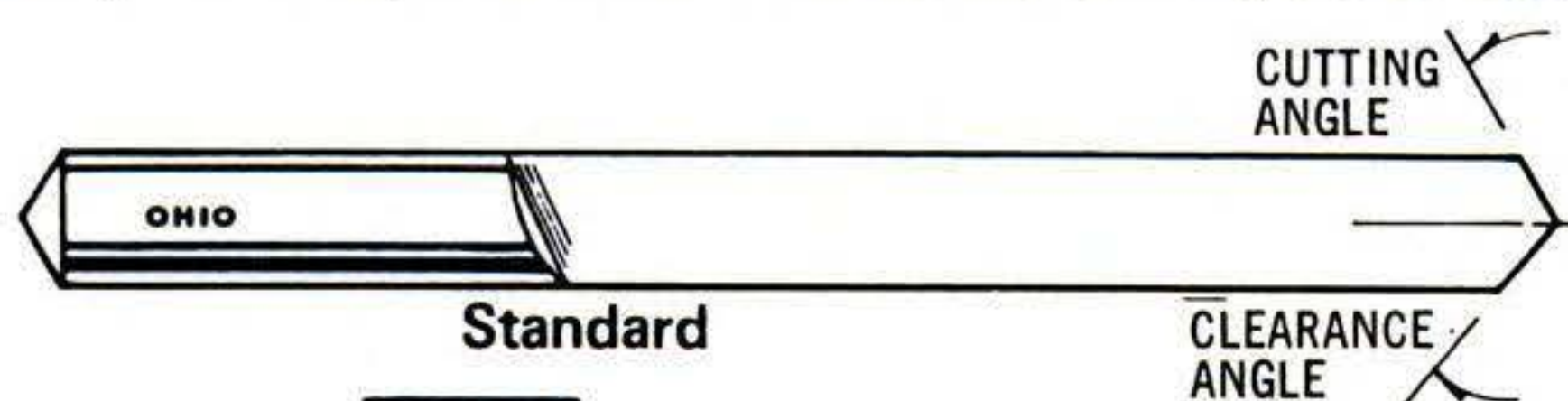
SHOP TALK

By ROBERT P. STEVENSON

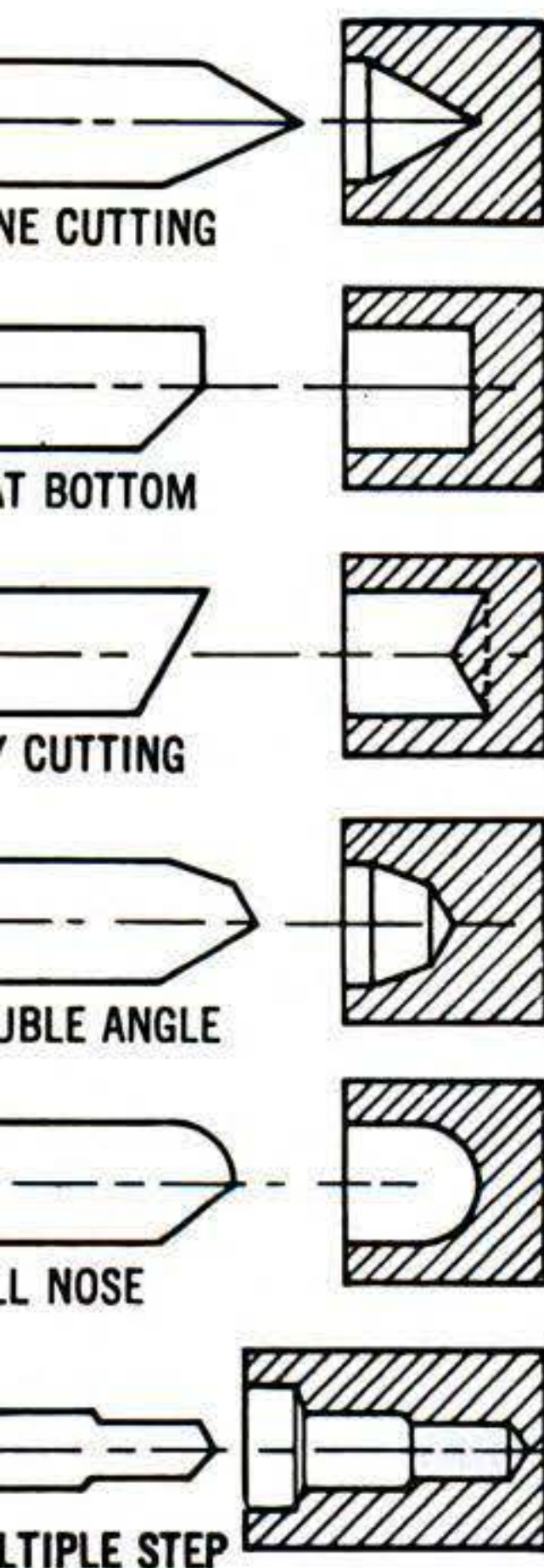
New circular-saw blade may be a better bargain than resharpening

When you sometimes must pay as much as \$1.50 to have a circular-saw blade resharpened, you might consider buying a new one instead. The Disston Flintstone line was introduced to the market some time ago with just that in mind. These blades have a suggested retail price of only \$1.64 for a 6½-inch blade and slightly less than \$2 for an eight-incher. Each tooth edge is induction-hardened for longer edge-holding. The blades can be resharpened if you wish—by grinding.

A special report about half-round drills, often called "D" bits



Those of you who think only of twist drills for machining operations ought to discover the merits of half-round drills. A half-round drill is a length of steel rod with half of the body removed to provide chip clearance and sharpened on the end to



cut various materials. During its long history, this drill has often been called a "D" bit, possibly because its cross section is shaped like the letter D. "A half-round drill will produce an extremely fine finish in holes far better than a reamer will do in most cases," says George E. Sanor, president of the Ohio Drill and Tool Co., Box 154, Homeworth, Ohio 44634. He says his company produces most of the world output of half-round drills. Literature about the drills is available for the asking. Depending on how the cutter is ground, a half-round drill will produce holes with a flat bottom, cone-shaped bottom, tapered bore, or even holes with a multiple-step diameter. (See sketches.) The drills are available in all American standard, metric, and decimal sizes from 1/64" to 5/8". Any good mechanic can easily resharpen a half-round drill, yet fantastic results are obtained in some materials before resharpening is required. A single sharpening of a cutting edge, Mr. Sanor reports, might be good for drilling equal to drilling a 1/4" hole 500 feet deep.

How many electric motors in your home? You may be surprised

Electric motors are a must in and around our homes. One reader reports that in his own home he counted 68 motors, 59 of them in more or less constant use. A room-by-room tabulation that he sent along showed the greatest number—21—in the basement and his two-area shop. Even the attic had its motors—for an air-conditioning air circulator and for the trapdoor (a reversible one). In the garage he included half a dozen motorized auto accessories.

When you install a new chain on a chain saw, break it in easy

Improper use can ruin a new chain the first five minutes it's on your chain saw. That's the word from experts at Omark Industries, Oregon chain producer, who advise soaking the chain in oil before mounting and tensioning it. Then run it at idle speed for about five minutes. Next make a few easy cuts, at no more than half throttle, while oiling liberally. Then stop the saw, let the chain cool, retension it and reoil. Work up to full speed gradually.

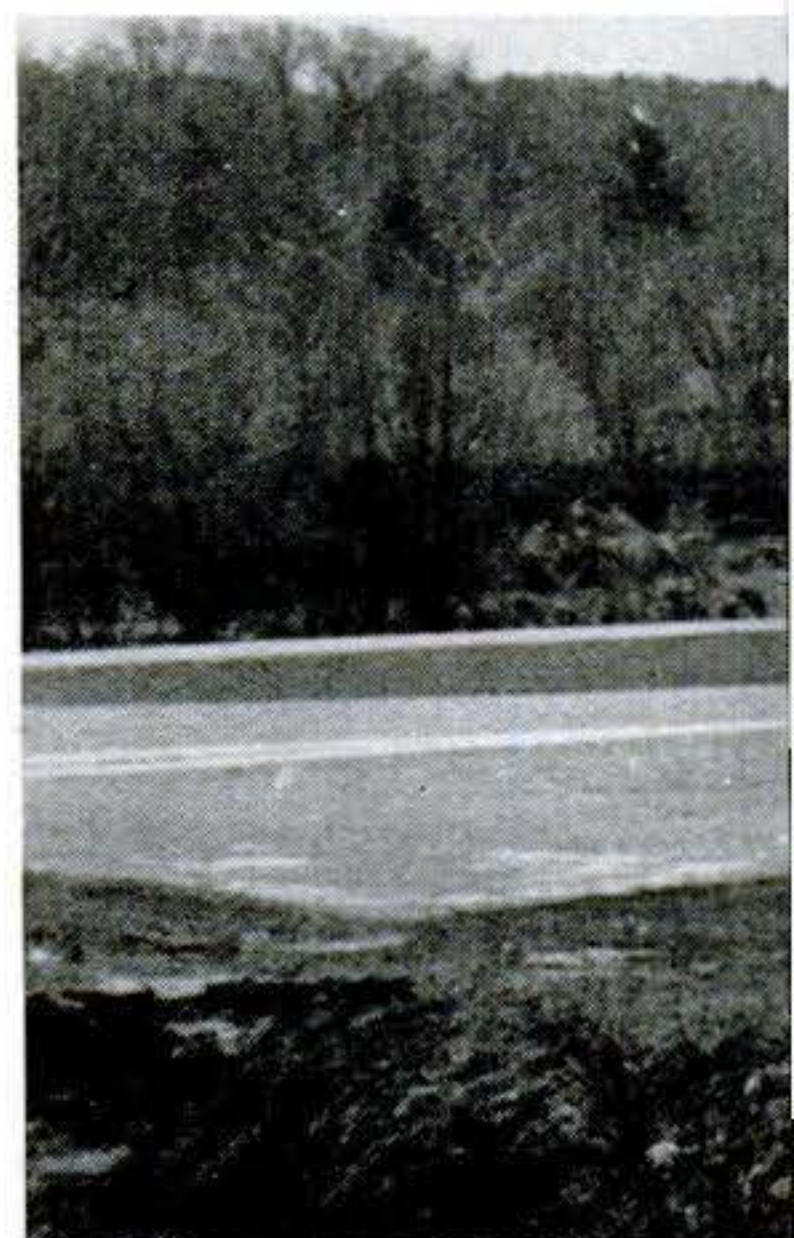
Thrills in Taking a Flight Test



After the months of training I still had anxieties and scars from a false scare as exam day loomed

By LEN BUCKWALTER

Gravel in my guts! Sitting in the plane waiting for runway to clear for takeoff was jittery moment.



My instructor grabbed the wheel out of my hand as our plane sailed over the runway, and in one motion dumped the wing into a steep bank and kicked the rudder pedal. The craft was now cocked at a crazy angle to the uprushing runway. Flying nearly sidewise, he could outmaneuver the crosswind trying to blow the ship toward the trees. Just before the landing gear would twist against asphalt, he swung the nose straight ahead and

plunked the plane safely on the ground.

That performance made me wish I'd never stepped into an airplane. I was scheduled to take my FAA flight test in four days. Maybe an instructor can play a two-seat Cessna against those wild winds; students are another story.

It had taken me eight months (four of them once-a-week at ground school) to reach this point. My logbook totted up 60 hours of flight time, and I'd passed



Ground nerves? In preflight check, dipstick test of oil calls for steady hand. For long flights, crankcase must contain six quarts; five, for shorter ones.



Was my face red! On a training flight, Buckwalter had to turn back because of strange noise. Coat belt, trapped outside door, was slapping fuselage.



the written exam. That three-hour ordeal covers navigation, how to use a compass and how to use chart and radio to leave Point A and find Point B. I could now decode weather symbols, and I had learned the FAA regulations.

Even my hangar talk was becoming polished. I learned never to say an airplane crashed. It is "bent" (a minor mishap) or "pranged" (a serious case).

But the learning phase was now over. It was March and continuing winds up to 30 m.p.h. were forecast. Why not wait until they subside? Well—students "forget to fly" if they stay out of the cockpit for much more than a week. The books call it "loss of proficiency." It's not only a beginner's problem; airline pilots are examined every six months for the same reason.

Dry run. There were other anxieties. What if I got lost en route to the exam? In 1968, the FAA took fixes to help more than 2,500 lost pilots find their way. Although my flight from home base (Danbury, Conn.) to the test area is only 20 miles, the countryside from 3,000 feet resembles a featureless crumb cake. The decision was obvious: a solo flight to the airport *before* the exam.

Next day, chill weather kept the air clear, and Poughkeepsie was reporting gentle breezes under 10 knots. So crosswinds were not a threat. I headed for Stormville, where I'd take my test.

As the plane lifted off and climbed to cruise altitude, the unthinkable happened. A sudden tat-tat-tat broke through the steady drone of the 100-hp. Continental. Engine failure flashed to mind and I scanned the ground below for the nearest cow pasture. "Don't panic," I urged myself. The prop somehow kept pulling the ship through the air at a normal 100 m.p.h. Again, tat-tat-tat. The engine's about to throw a rod, I thought, or the carburetor's icing up. I gingerly turned the plane toward home while the craft was still under control.

Once on the ground, I mentally kicked myself after discovering the trouble. The belt from my raincoat! Left dangling outside when the door was closed, it flapped in the airstream when the ship reached cruising speed, flailing its brass eyelets against the aluminum fuselage. I hoped that none of the boys in the hangar saw me retrieve the trailing belt, then take off again. Stormville proved easy to find.

Continued

On test day, the weather was spotty. Albany, N.Y., and Wilkes-Barre, Pa., reported light snow. There was a perimeter of forbidding weather about 100 miles away. Would it hold off for the next six hours? A call to a nearby FAA station netted an encouraging forecast; scattered clouds at 3,000 feet (enough to fly under) and possible improvement later.

Take-off time: 45 minutes away. There was the traditional shakedown between student and instructor to detect any missing items that could mean failure. First, there's the instructor's written recommendation to the examiner that you're ready for the flight test. Papers are checked—airplane and engine logbooks, medical and radio certificates, and your score on the written test. Then we ticked off everything on a checklist, down to the final entry: *Common Sense*. You can fly like an Eddie Rickenbacker, but it's this item, say the old timers, that really wins the ticket.

As my ship touched down at Stormville later, I glanced at the wind sock. It hung straight down! Nary a breeze stirred. My only worry now was examination jitters. What if he asks me to execute some Red Baron maneuver that spills the ship into a spin . . . I lose control . . . he takes over? But my examiner was Wilfred McAdams, who's probably been in the flying game longer than most. The FAA has about 80 offices where a flight test can be taken, but it also appoints highly qualified flight instructors like McAdams at other locations. I'd taken the written exam at New York's Kennedy Airport, but wouldn't dare fly in air filled with "oil burners and heavy wagons."

The flight test consists of numerous big and little requirements, but adds up to a single question: Can you plan and safely fly a cross-country trip?

The flight test actually begins on the ground. You must be ready to verbally answer any question about the aircraft's range, fuel capacity, and performance. You'll do a complete walk-around to de-

termine if the ship is ready for flight (any missing gas caps? how's the oil level). I was asked to name the documents carried aboard. I shot back "airworthiness certificate, registration, flight manual, and radio license."

As we got into the ship McAdams said, "What's the emergency radio frequency?" Another easy one—"121.5"—a number burned into my brain for obvious reasons. I could feel eyes on me watching the engine-starting procedure, instrument and control checkout, and taxiing technique.

We're up and away! Then began the second phase: basic piloting technique. Pointing to a tree in a field, McAdams said, "We'll do some steep turns around that tree." This apparently simple maneuver is required for good reason. The winds were 20 m.p.h., which meant I had to continuously adjust the plane's turning rate to correct for drift. Otherwise, the plane would no longer circle the original point. The maneuver is also stressed for safety's sake. Knowing how to control a plane in a steep turn prevents a dangerous spiral from developing.

Now the ship curved upward in a climbing turn, leveled off, and headed off. McAdams hardly said a word as he appraised piloting technique—the multitude of chores that contribute to efficient flight, like proper engine r.p.m., the right combination of rudder and aileron in a turn, correct airspeed and correct altitude.

"Okay, let's do a departure stall," said McAdams. This is another maneuver to keep beginners out of a nasty situation. Such stalls can happen just after takeoff when the aircraft begins its first turn. Unless airspeed is high enough, the turn can induce a stall that might drop the plane to the ground before there's time for recovery. The stall is done intentionally at a safe altitude to let the student feel its warning signs and learn recovery.

At 3,000 feet I began the stall by increasing power, entering a turn, and pull-



I've got it! Author says he felt like doing a jig when the flight test ended and he had a temporary ticket—good until the permanent license arrives.

[\[Continued on page 192\]](#)



Saber saw quickly cuts flue holes in ceiling and roof over the fireplace. Metal pipe has seven-inch diameter.

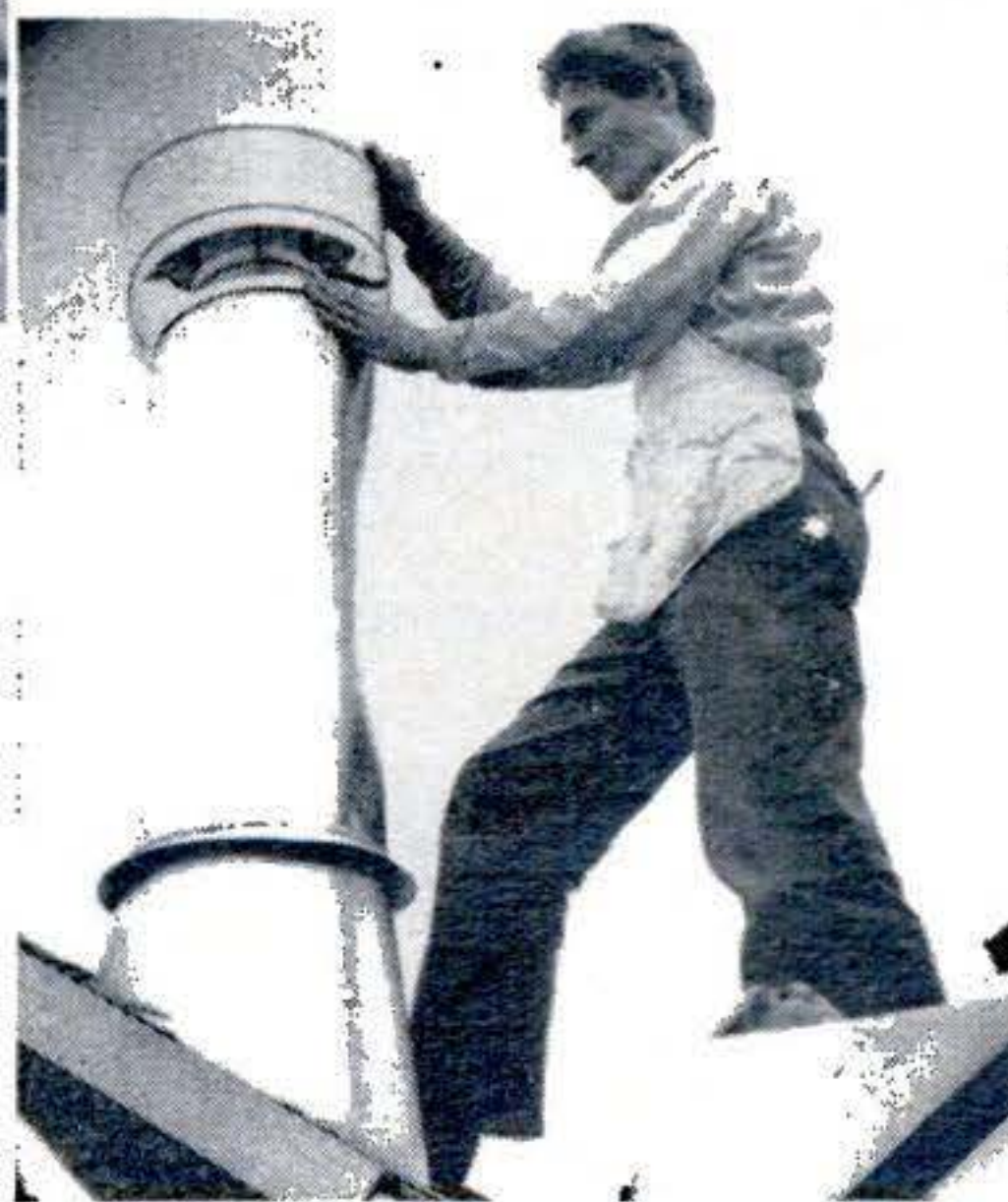
CERAMIC FIREPLACE is a one-day job

By DARRELL HUFF

Someone can begin chopping wood the moment your Aztec arrives. Two of us installed one from scratch in an afternoon. With an existing flue and hearth it would have taken minutes. We laid a slate hearth with ceramic-tile adhesive, but $\frac{3}{8}$ -in. asbestos board works well too and takes less time.

We bolted the gold-colored ceramic pot to a spun-steel base and set it in place on the hearth. Directly overhead we cut circular holes in ceiling and roof. The stainless-steel flue sections slipped onto the fireplace top; we fitted a black outer housing over them. A cap assembly topped the flue outside.

We finished the job with flashing at roof level and an adjustable collar between flue and ceiling. The Condon-King Co., 5611 208th S.W., Lynnwood, Wash. 98036 makes Aztec fireplaces in five colors.



Storm cap tops flue; it's fastened to the roof with sheet-metal screws. Flashing waterproofs flue-roof joint.



An adjustable metal collar covers the gap between flue and ceiling inside. Now you can light the fire.

How to Duplicate Small

Here's a great new technique for reproducing broken or lost parts for your home or shop

By MACK PHILIPS

Need a left-handed bolt? Or perhaps hardware for an antique lamp? Then try a homemade casting.

Reconstructing an obsolete part or making a special metal-like component for a shop project is easy with castable, metal-filled liquid epoxy plastics. You use the part, if it's available, as a pattern to make a duplicate. If the part is missing or you need a new design, just make a pattern from wood, clay, or whatever suits the purpose.

The stuff you use. Sometimes called "tooling epoxies," the casting materials are used industrially for making temporary dies, jigs, holding fixtures, and prototype parts. Happily, they are available in small quantities for home use.

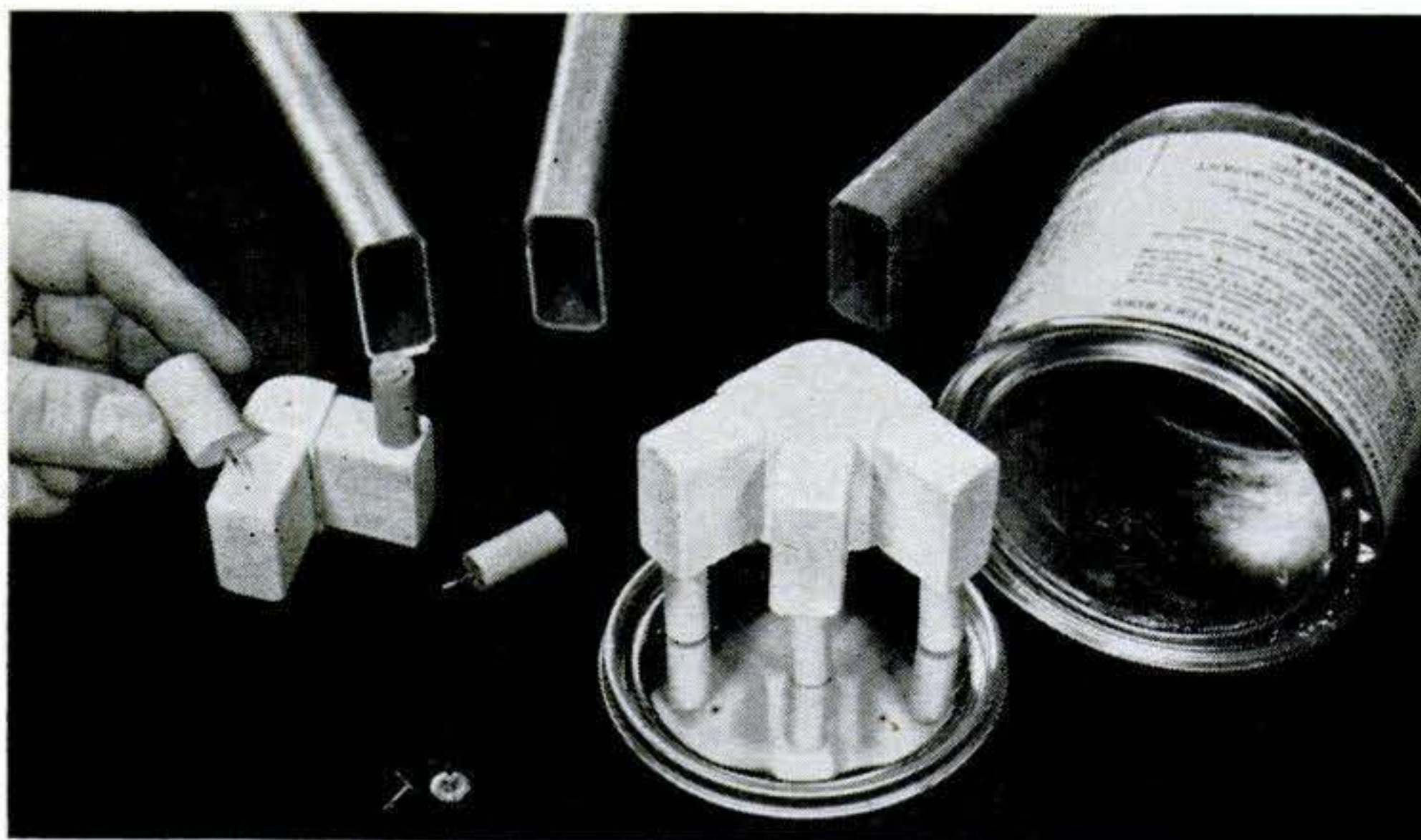
Just what are they? They're finely powdered steel, iron, or aluminum held together with epoxy-plastic binders. Add a hardener liquid, and the syrup-like mixture sets up in a few hours as a metal-like substance.

Plastic-metal parts are not as hard or as strong as real metal castings, but they're fine for applications where great strength is not required. Where strength is important, a plastic-metal substitute may make do while a replacement is acquired. The castings can be filed, drilled, and sawn much like soft metal, and, of course, can be sanded and painted.

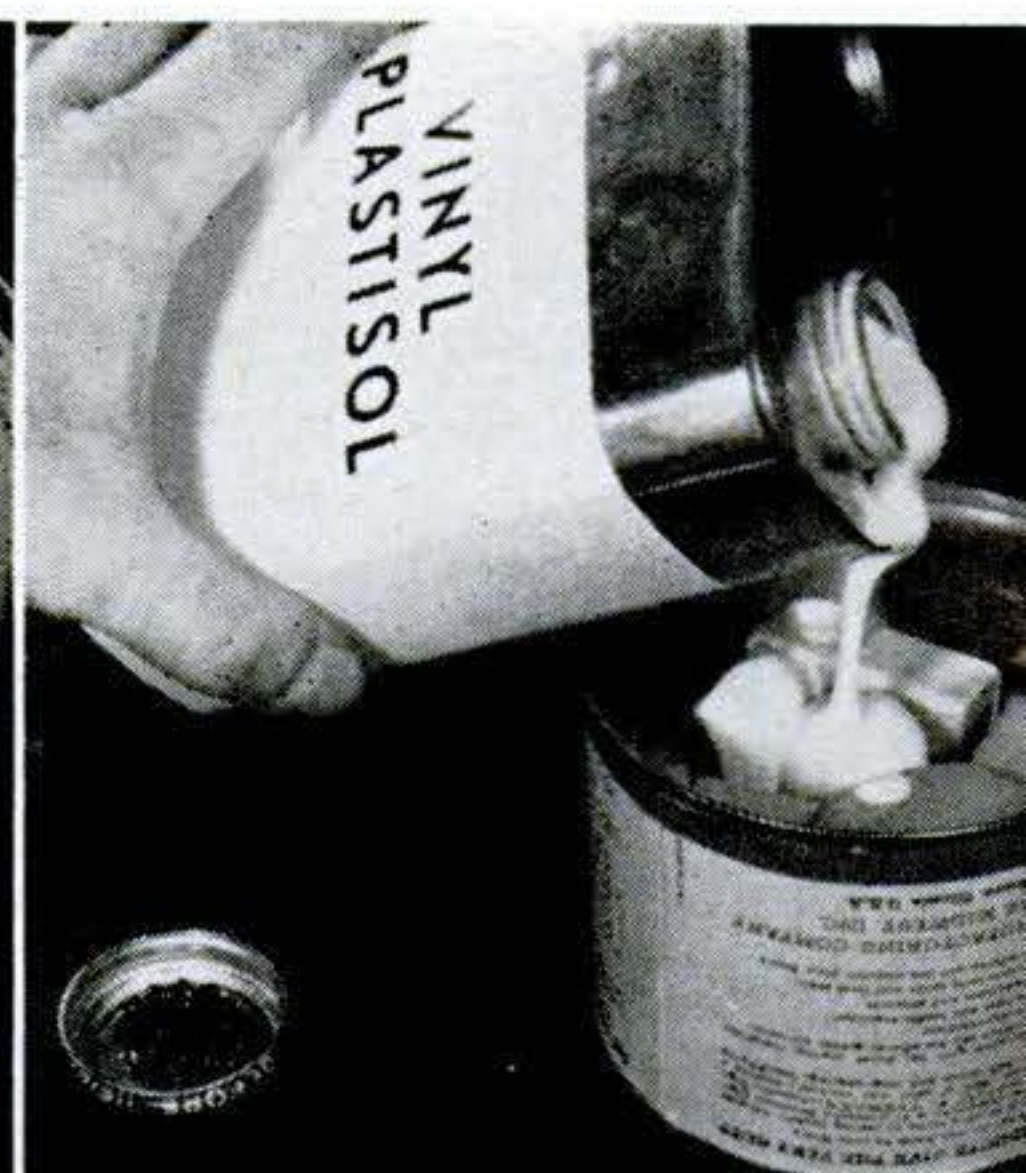
A companion product that makes the process a breeze is vinyl plastisol, a liquid mold material that cures into a tough, flexible shape when baked in the kitchen oven.

When I found out about metal-filled epoxies, I discovered an answer to a lot of little workshop jobs I'd been setting aside. I cast a crank to replace a broken die-cast part by patching it up with short chunks of dowel for just long enough to

How to cast complex parts in flexible molds



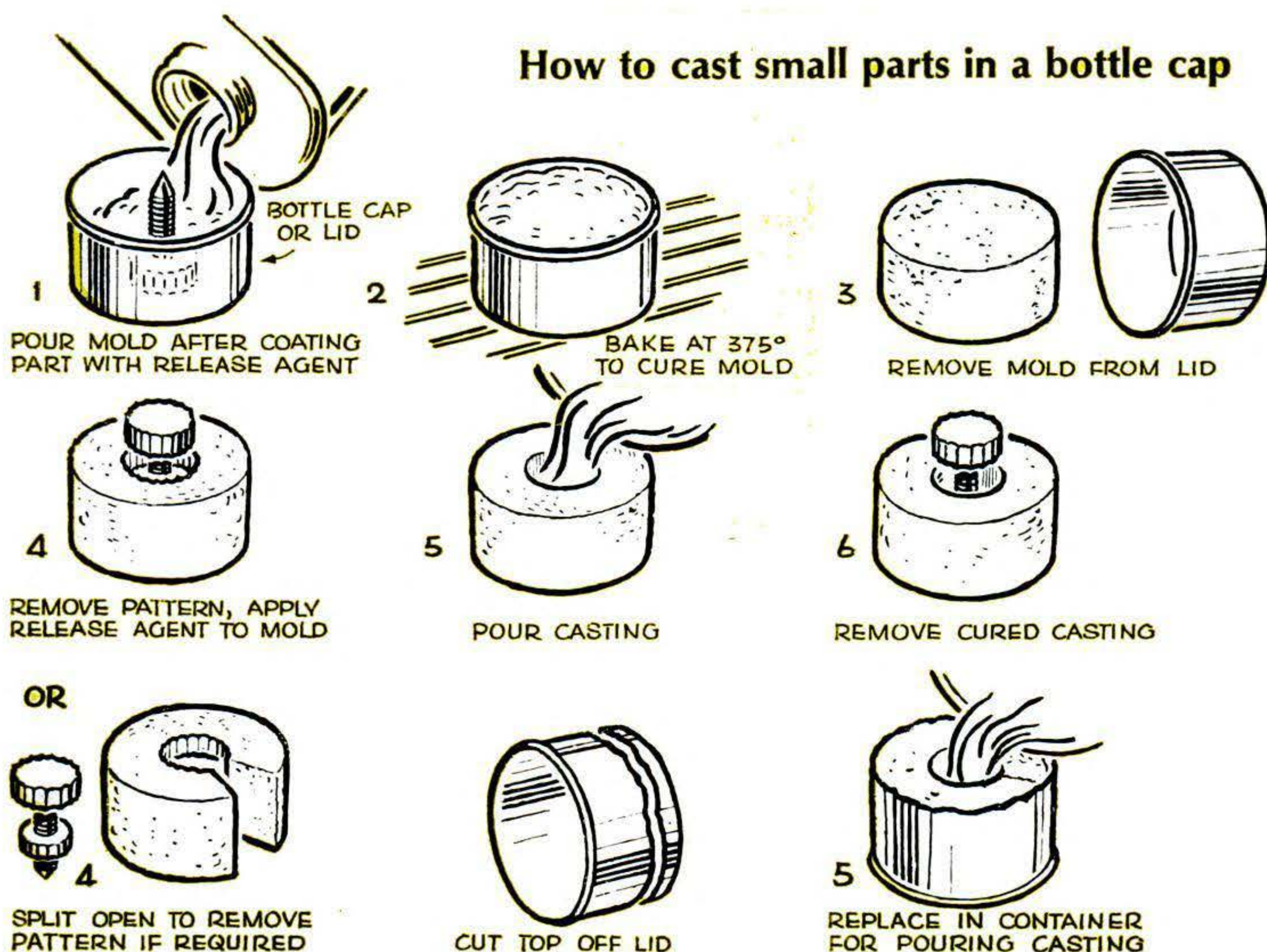
Custom tube corners are typical of many-faceted shapes that can be cast in a container. For easy removal from mold, sprue and vent portions of wooden patterns were made of dowel, attached with brads, as above. Patterns can then be held to can lid with



thumbtacks to prevent floating. Can with bottom cut out is placed over lid and vinyl plastisol is poured in to cover patterns (second photo). After mold has been baked and cooled, remove from can, pull out detachable vent and sprue dowels, and slit flexible

Parts by Plastic Casting

How to cast small parts in a bottle cap



mold just enough to remove patterns. Put mold back in can for pouring the plastic metal. Finished aluminum epoxy castings (above) can be screwed or cemented in aluminum tubing as corner joints. Buffed with steel wool, they closely resemble real aluminum.

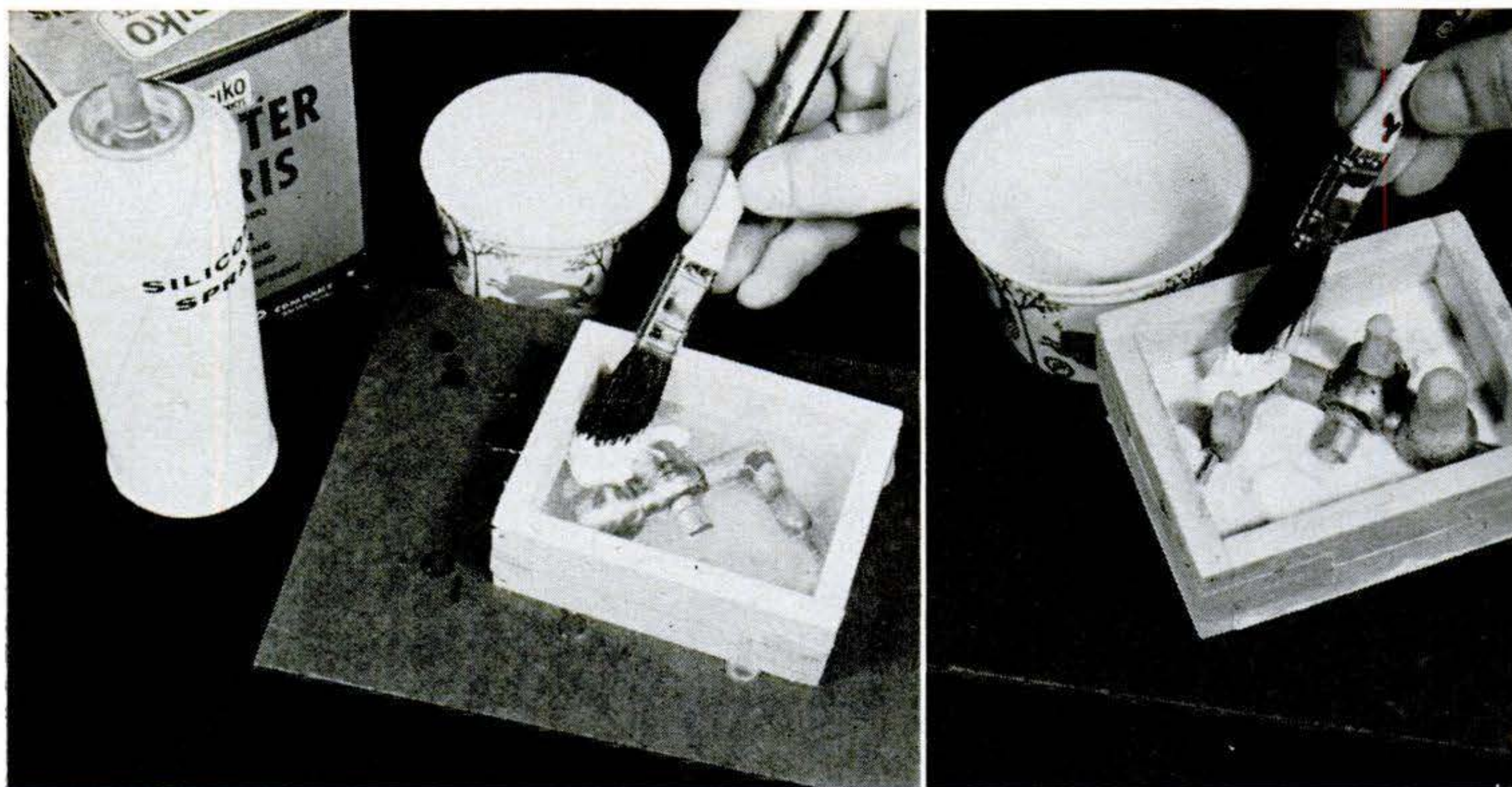
make a mold. And I made a little drill jig to hold and duplicate-drill a batch of odd little bearings I'd been wanting to make.

Wood patterns were fashioned to make aluminum corners for a batch of aluminum tubing I'd been trying to figure out how to assemble. I also made a "metal" emblem by gluing plastic letters to a wooden frame for a pattern. After I had painted the finished casting, I sanded the border and the numbers to show up the bare "metal."

Steel and aluminum compared. Specs on the materials show aluminum-filled epoxies less strong than those filled with steel, but I found them a bit easier to pour. The aluminum mixtures seem to have a greater tendency to entrap air bubbles. To eliminate bubbles, I combined the

Continued

Casting with parted plaster molds



Two-part plaster molding is begun by embedding pattern halfway in paraffin. In photo above, pattern is broken crank built up with wood to replace missing portion. Note short pins at end and bolt in hub.

Initial plaster coat is applied with brush to insure good casting detail. In second photo, mold is inverted, paraffin removed. Clay is stuck on to provide sprue and vents. Bottom half of mold is lubricated

epoxy and hardener by very slowly stirring, and then let the mixture set awhile before pouring. The liquids start to set up in about three quarters of an hour, so have things ready before you mix the two components. They become fully hard in about 24 hours, depending on prevailing temperature and humidity.

Two mold materials you can use. For parts that are large, or made of material that would melt in a mold-baking process, common plaster of paris mixed to soupy consistency is suggested as a cheap mold material.

Simply make a temporary box frame of scrap wood to hold the pattern, and pour it full of plaster.

Slight taper away from the base surface must be provided on patterns for plaster-casting to allow pattern removal without damaging the mold. Clay can be used to "lag" holes or undercuts, and to taper the edges of existing parts used as patterns.

Cured vinyl plastisol is flexible and can be stretched to remove a pattern from a complex mold. Molds can be slit open to remove the pattern, if required. Plastisol reproduces fine pattern detail.

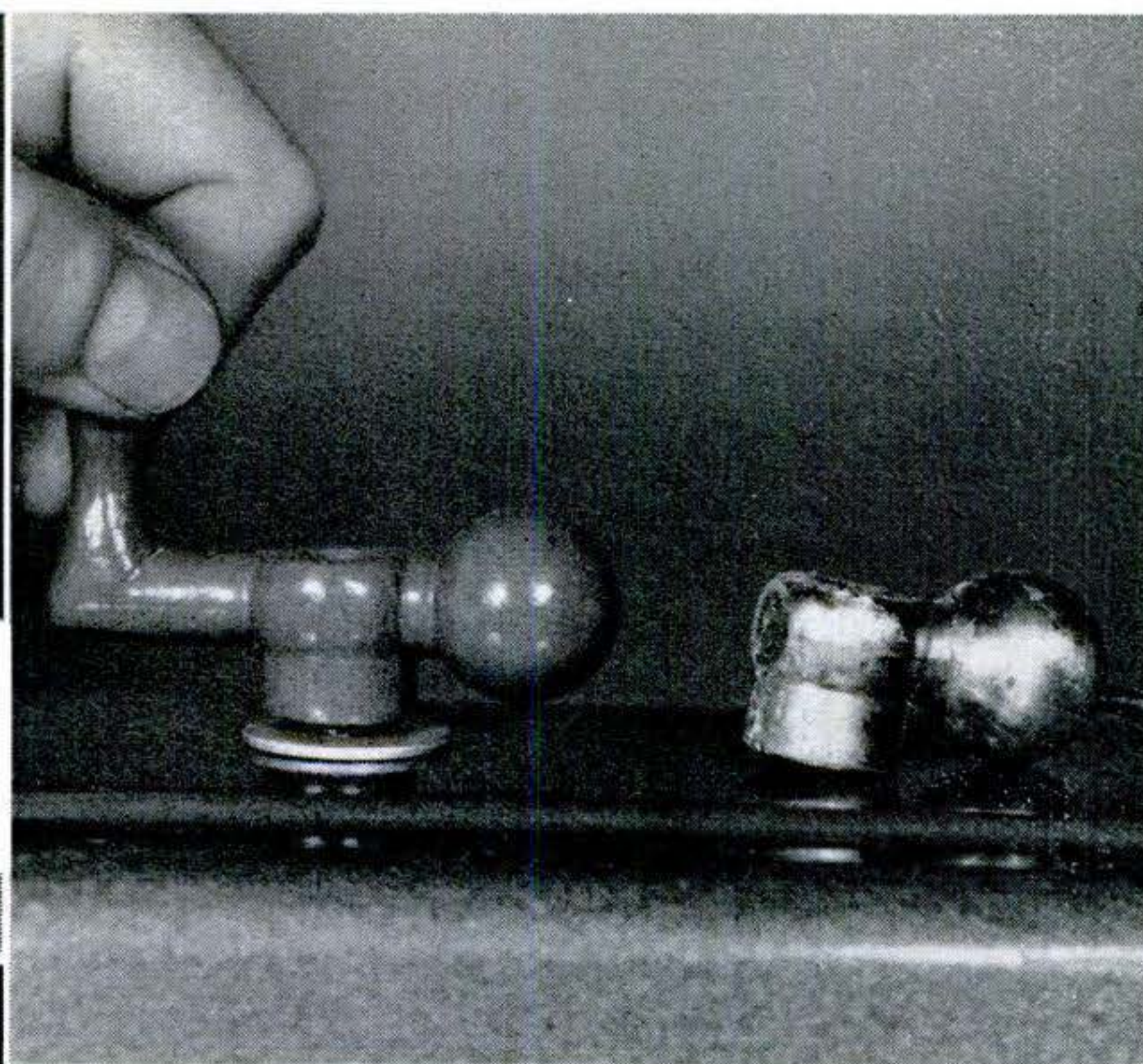
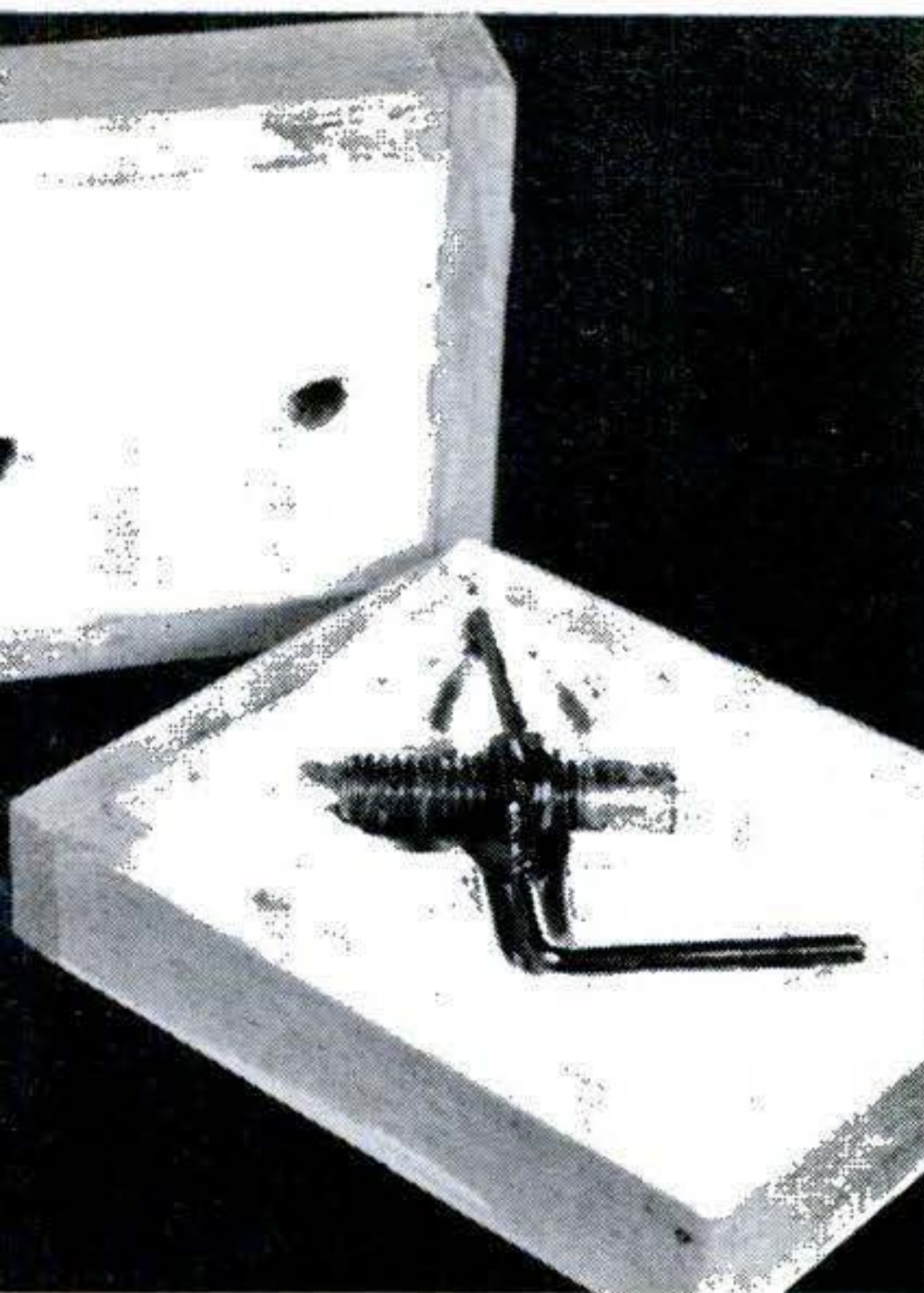
Vinyl plastisol is cured by baking at about 375 degrees. I found it advisable to

bring the oven to about 200, and then up it to 375 degrees to prevent bubbling and swelling of large molds. Wood patterns should be sealed. Coat patterns with a release agent. With the exception of simple jobs like bottle-cap and flat molding, vents must be provided to allow air to escape at each end of a mold cavity. These can be added to the patterns as illustrated in the photos. The liquid plastics are quite thick, so be sure to provide a large hole or "sprue" to afford easy pouring.

Where to get materials. Metal-filled casting epoxies are available at some hardware stores, and many industrial and plastic supply stores. Two of the brands are Devcon (Devcon Corp., 59 Endicott St., Danvers, Mass. 01923) and Smooth-On (Smooth-On Mfg. Co., 572 Communipaw Ave., Jersey City, N.J. 07304).

A mail-order source of vinyl plastisol, under the trade name of "Co-Flex," is Cope Plastics, Highway 100, Godfrey, Ill. They also handle Devcon products.

A silicone rubber that vulcanizes at room temperature can also be used as a flexible mold material. Both General Electric (Silicone Products Dept., Watford, N.Y.) and Dow Corning Corp. (Midland, Mich.) make such a product.



prevent second pour from sticking. Pattern is removed, above, and wire placed in mold to reinforce casting; ends will be cut off after casting has cured. Pin used in mold-making is coated with release

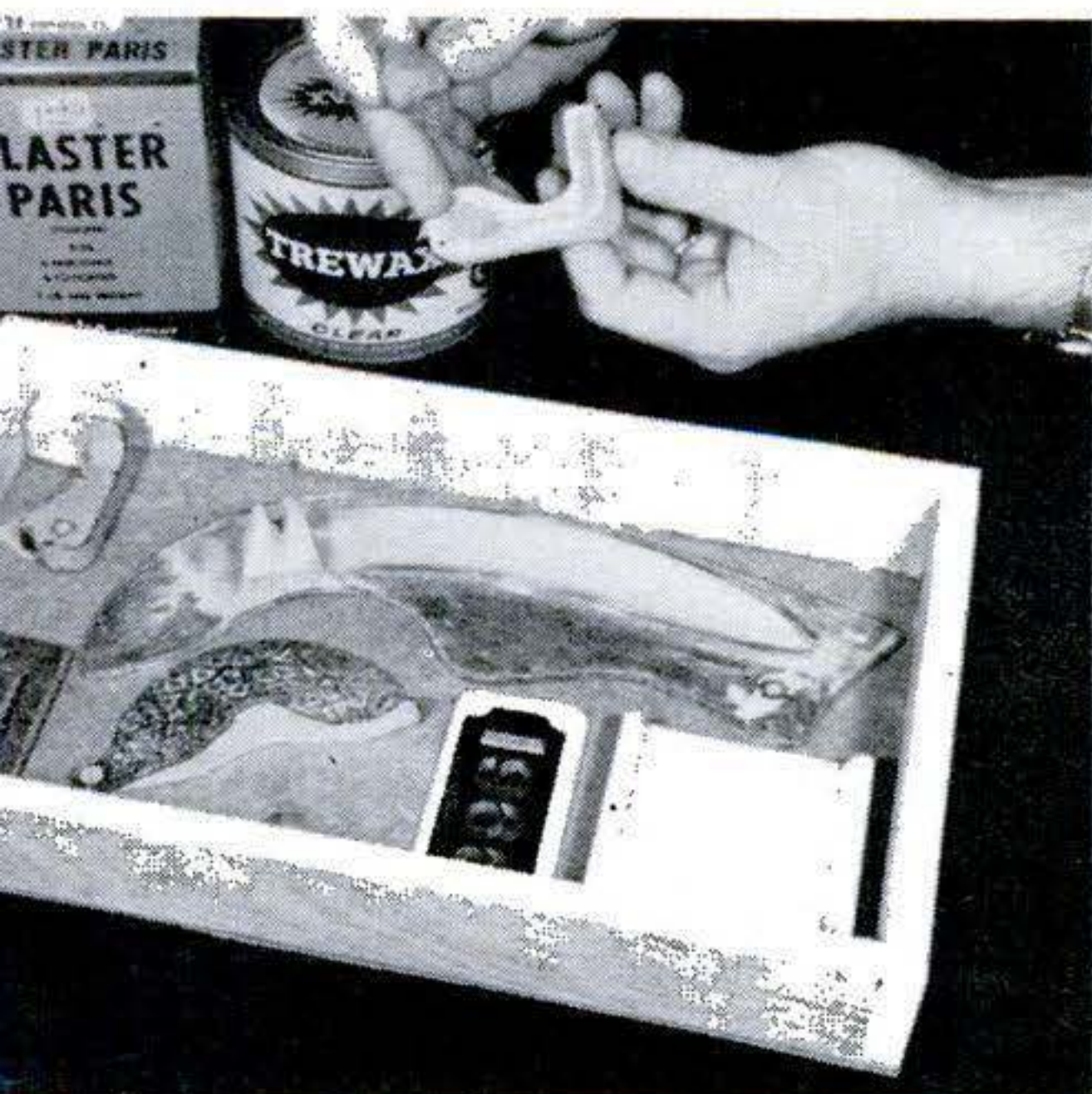
agent to form threads in casting. Note pouring and vent holes in top half of mold. Final photo shows casting next to broken original. Pin at right end provided mold recess to hold reinforcing wire.

They're two-part, liquid, rubber-like materials that will cure in thick sections not to be confused with the tubed bath-tub-caulking silicone rubbers sold in the hardware store. They are handled much the same as vinyl plastisol, except that

they require no baking to cure. That's an advantage when the pattern is of a material that can't stand heat.

With these supplies on hand, you'll be equipped to tackle any small casting job you're likely to encounter. **PS**

Casting flat-sided items in a plaster mold



Large items with flat backs are cheaply molded in a wooden frame with removable bottom. Dabs of clay stick parts down, build up undercuts. Paste wax keeps plaster from sticking to patterns. Fill box with

plaster, invert to remove bottom and patterns. Second photo shows how reinforcements can be placed in recesses to strengthen cast parts: bent wire at weak point of lathe guard, wire screen for flat item.

ELECTRIC POWER



Drive your tractor to the job, hook up the alternator, and plug in electric tools and appliances.



Mounting this 4,000-watt alternator on the back of a tractor took two sentry pins and one bolt.

This generator runs off your garden tractor to give you power anywhere



A transfer switch is better, author says, using a plug and heavy-duty switch to feed standby power into his house.

If you've always wanted an emergency generator and already own a garden tractor, consider the new GenerAC alternator. Unlike conventional portable power plants, it:

- Runs off the tractor's engine, requiring none of its own. This cuts the cost by more than half.
- Rides on the tractor, making it truly portable.
- Starts as easily as your tractor, which is more often used than most emergency generators.

Tractor-mounted power works beautifully. All it takes is a few brackets and pins for mounting, plus a V-belt drive from the engine countershaft or power takeoff. These parts come in kit form from GenerAC for most tractors.

You make no electrical connections to the tractor. Simply start its engine and pull out the hand throttle until the alternator's needle reads in the green sector of the dial—indicating an output of 115 volts, 60 cycles AC. Plug in your drill, pump, saw, compressor, flood lights, or whatever, and you're ready.

GenerAC tractor alternators come in two sizes: 2,400 watts (model 5678) and 4,000 watts (model 5679). The smaller one generates 115 volts only, the larger one 115 or 230 volts. Figure on two horsepower for each 1,000 watts; you'll need an eight-hp. tractor to run the 4,000-watt alternator, for example. Motor-starting loads, often a problem with portable generators, are handled by a special overload winding on the two GenerACs.

The GenerAC Corp. (Box 8, Waukesha, Wis. 53186) sells the 2,400-watt alternator for \$160, the 4,000 watt for \$215. Tractor-mounting kits are extra.

WHERE YOU NEED IT

by E. F. LINDSLEY

PS Outdoor Power Equipment Editor

This unit delivers 115 volts in your RV or home

What surprised me most about the new GenerAC XP power plant was how quietly it ran. Inside the motor coach it was no louder than a refrigerator, quieter than a window-type air conditioner. Outside I couldn't hear it from 10 feet away.

The XP has other unusual features, such as a Forest Service-approved spark-arresting exhaust, a sealed and leakproof carburetion system, blower cooling, an optional built-in fire extinguisher, a four-quart oil tank with a low-level cut-off switch, tuned elastomer suspension, and a thermostat-operated shutter to control generator-compartment temperature.

This is one self-contained power plant that's built to last. Its heavy-duty 12-hp. engine has Timken bearings, Stellite exhaust valves and rotators, cam-ground pistons, and solid-state ignition. A compression release and automatic choke make starting easier. The entire unit—engine and alternator—is built to industrial standards for long life.

One feature I liked particularly was the 12-volt battery charger and battery-conditioning

air filter also acts as an intake-silencer and a Forest Service-approved flame arrester.

An optional fire extinguisher shoots out dry powder when a fusible link (between fingers) melts through.

Control panel inside RV lets you start generator, cut in battery charger, and read battery voltage.

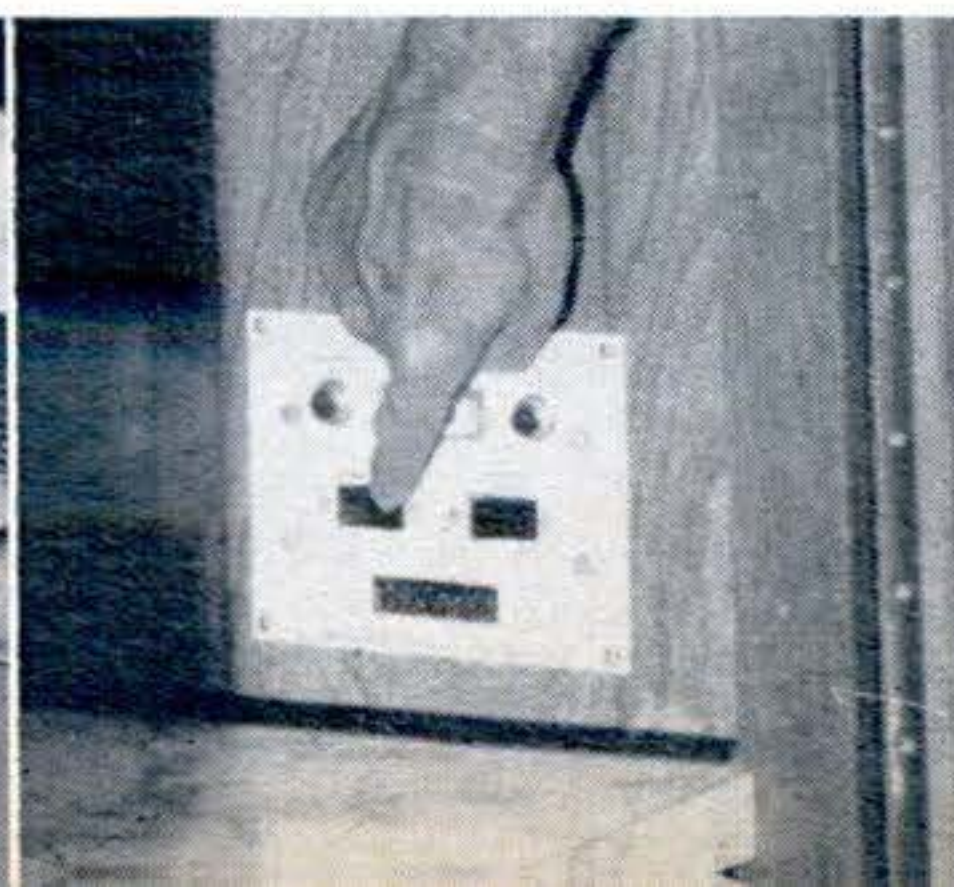
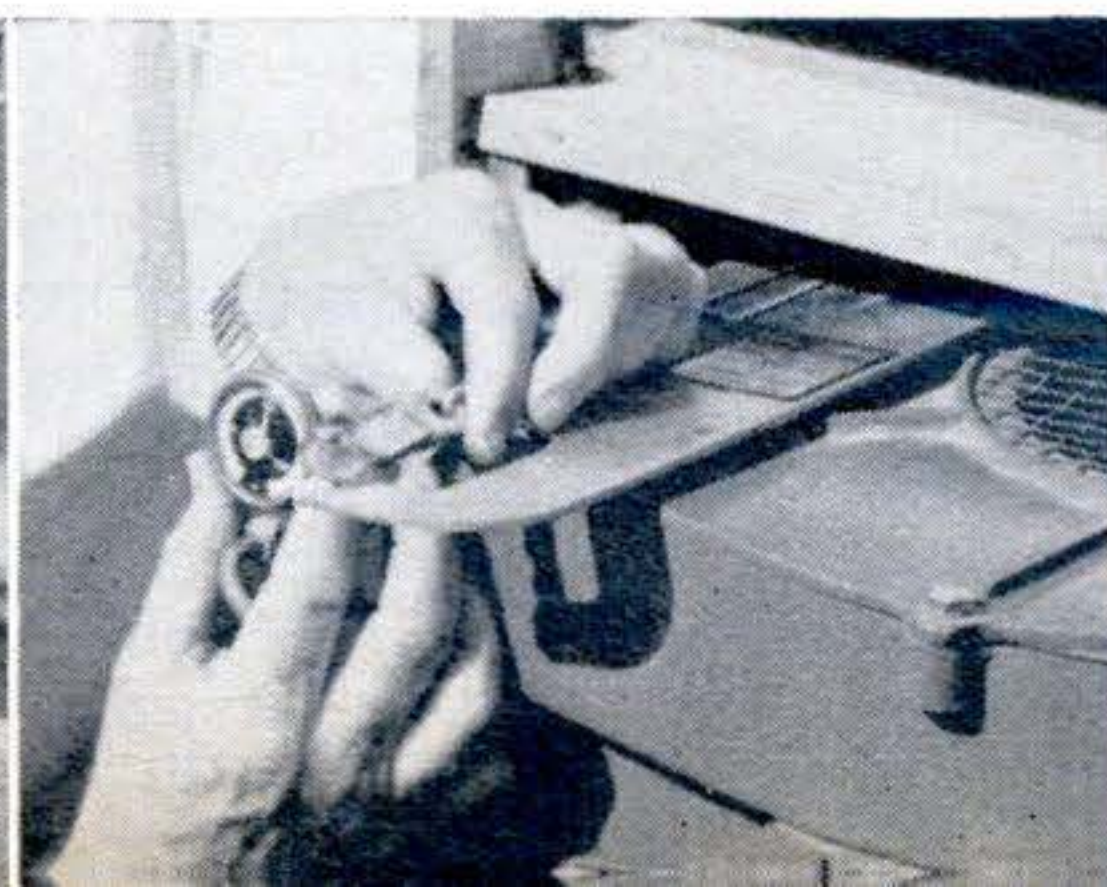
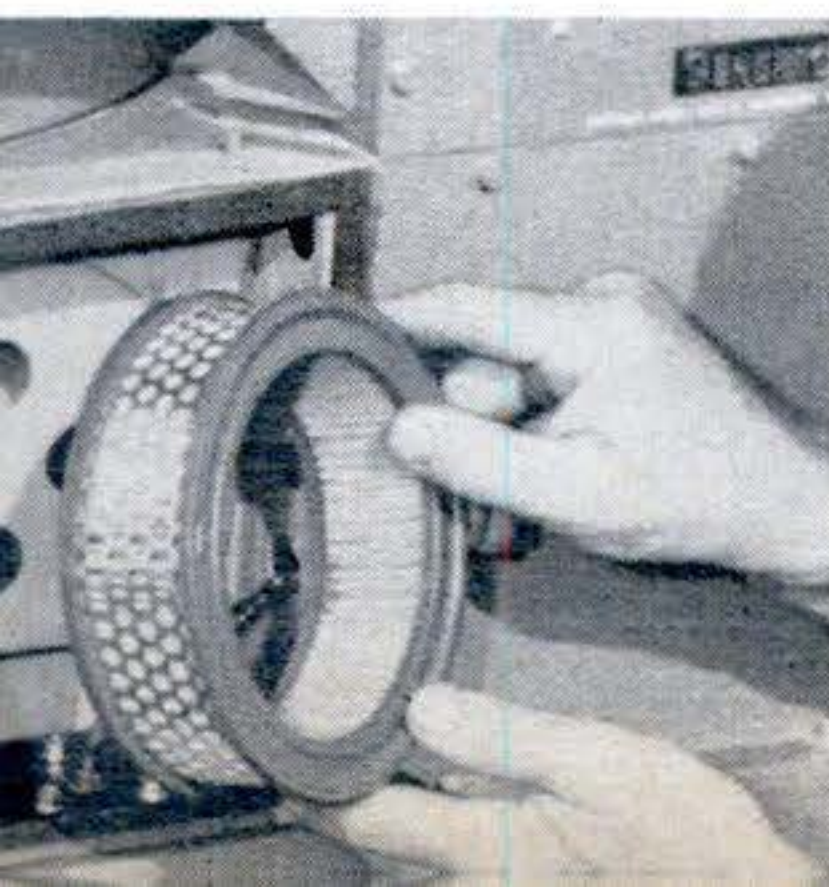


Mounted in a motor home, this 3,500-watt GenerAC XP slides out on rails, generates both 12 and 115 volts.

tion indicator on the XP. With it I could charge the RV's battery while driving. Or, using the 115-volt output, I could run appliances or reading lights underway.

GenerAC XP plants come in three sizes. The 2,500-watt alternator weighs 214 pounds and sells for \$746, the 3,500-watt unit, 289 pounds, costs \$859, and the 5,000-watt model, 305 pounds, carries a \$998 price tag. Installation and optional features will cost you extra.

For use as a standby residential plant, GenerAC Corp. of Waukesha, Wis., makes a housing for the XP that's complete with fuel tank, thermostatically controlled oil-pan heater, and 100-amp. manual transfer switch. It's an extra \$268.



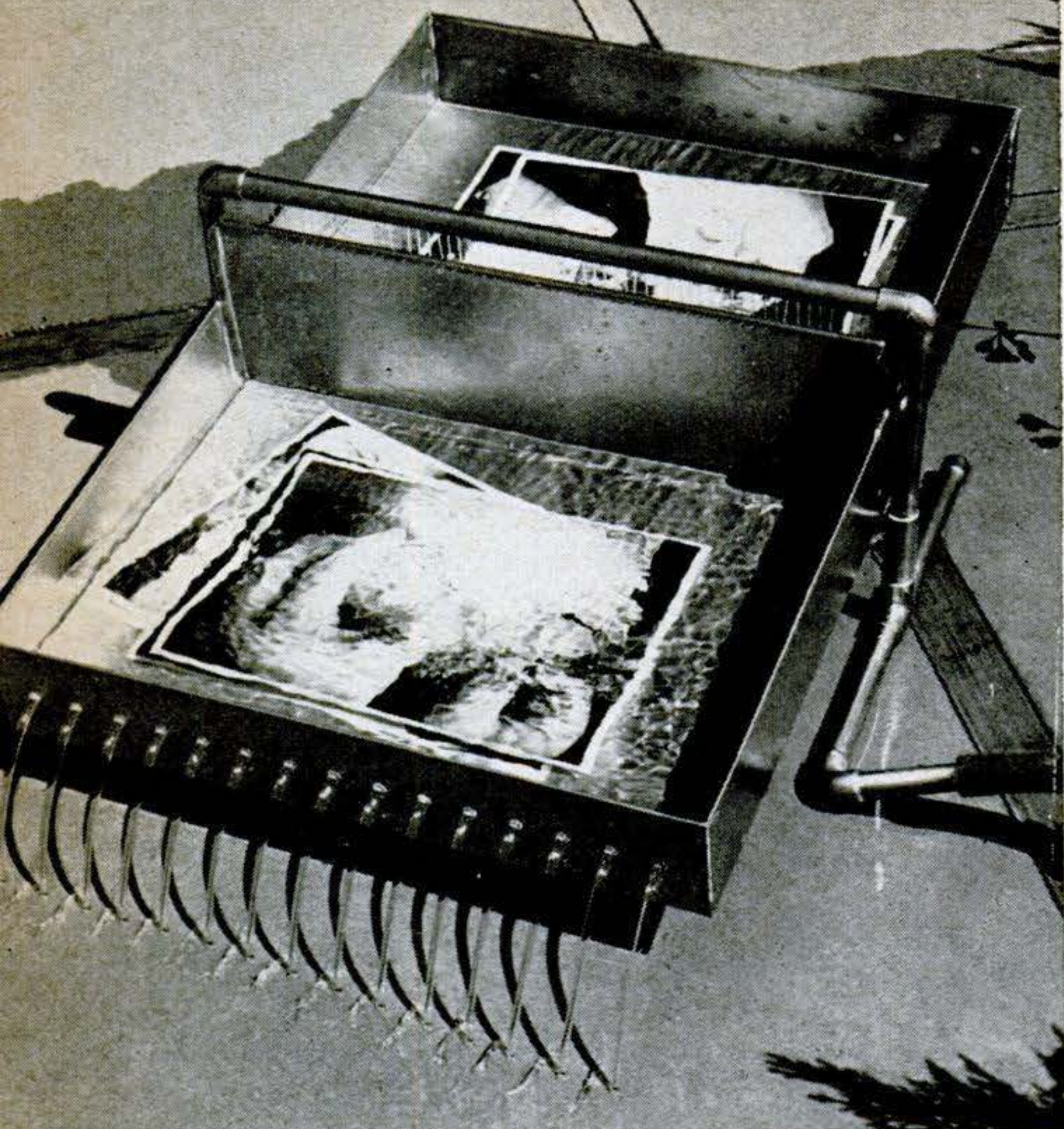


Photo Print Washer Rocks Itself

By BOB GILMORE

One secret of photographic prints that last just about forever is thorough washing. The constant agitation built into this self-rocking washer guarantees just that—and it does the job in record time.

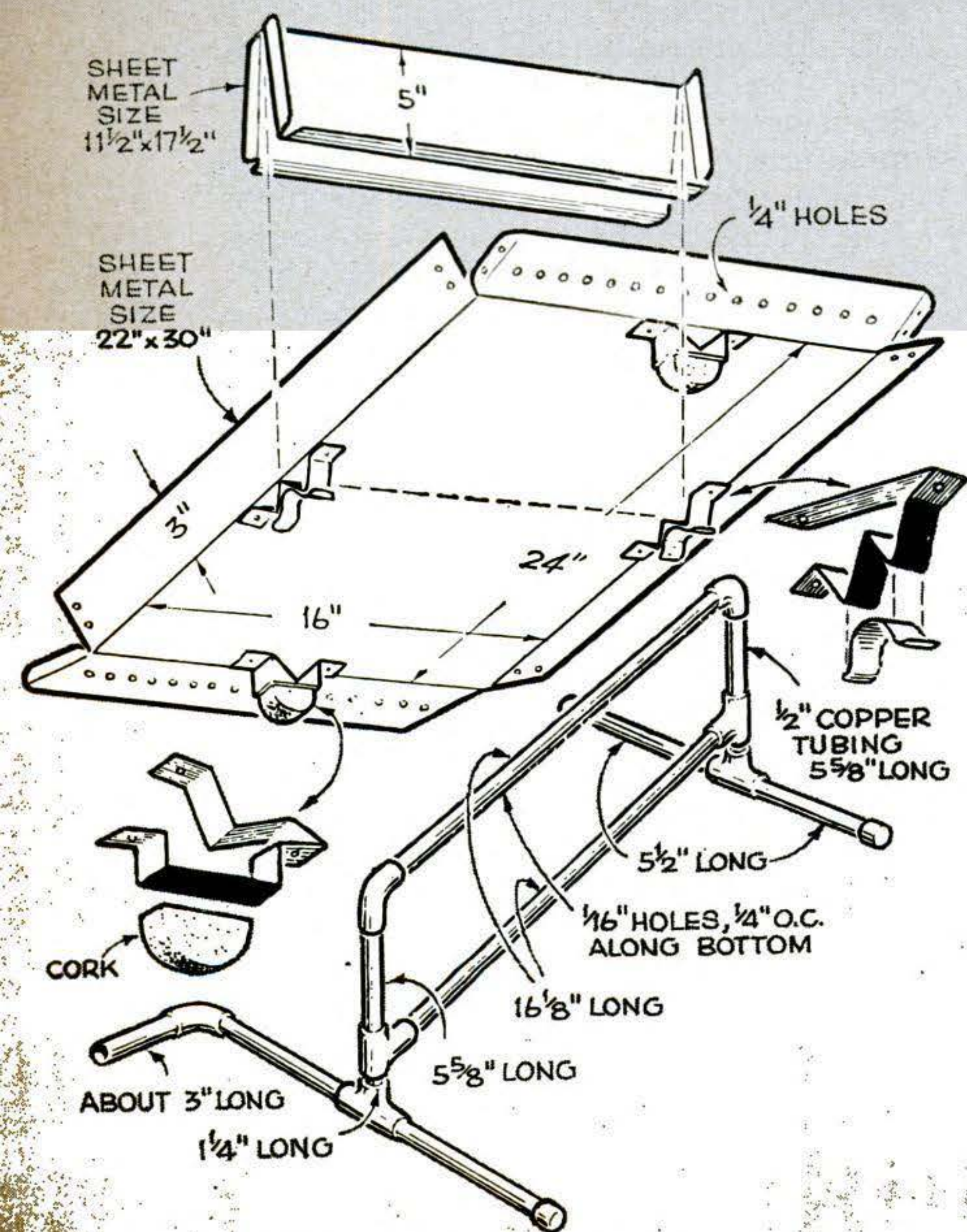
Water enters through a short piece of hose slipped over the open end of a framework of $\frac{1}{2}$ " copper tubing. It flows out through a series of holes drilled in the upper crossbar of the frame. When one half of the washer box has filled, weight of the water tips it down, allowing water to drain out of holes in the end of the box. The other half then fills, and the action is repeated.

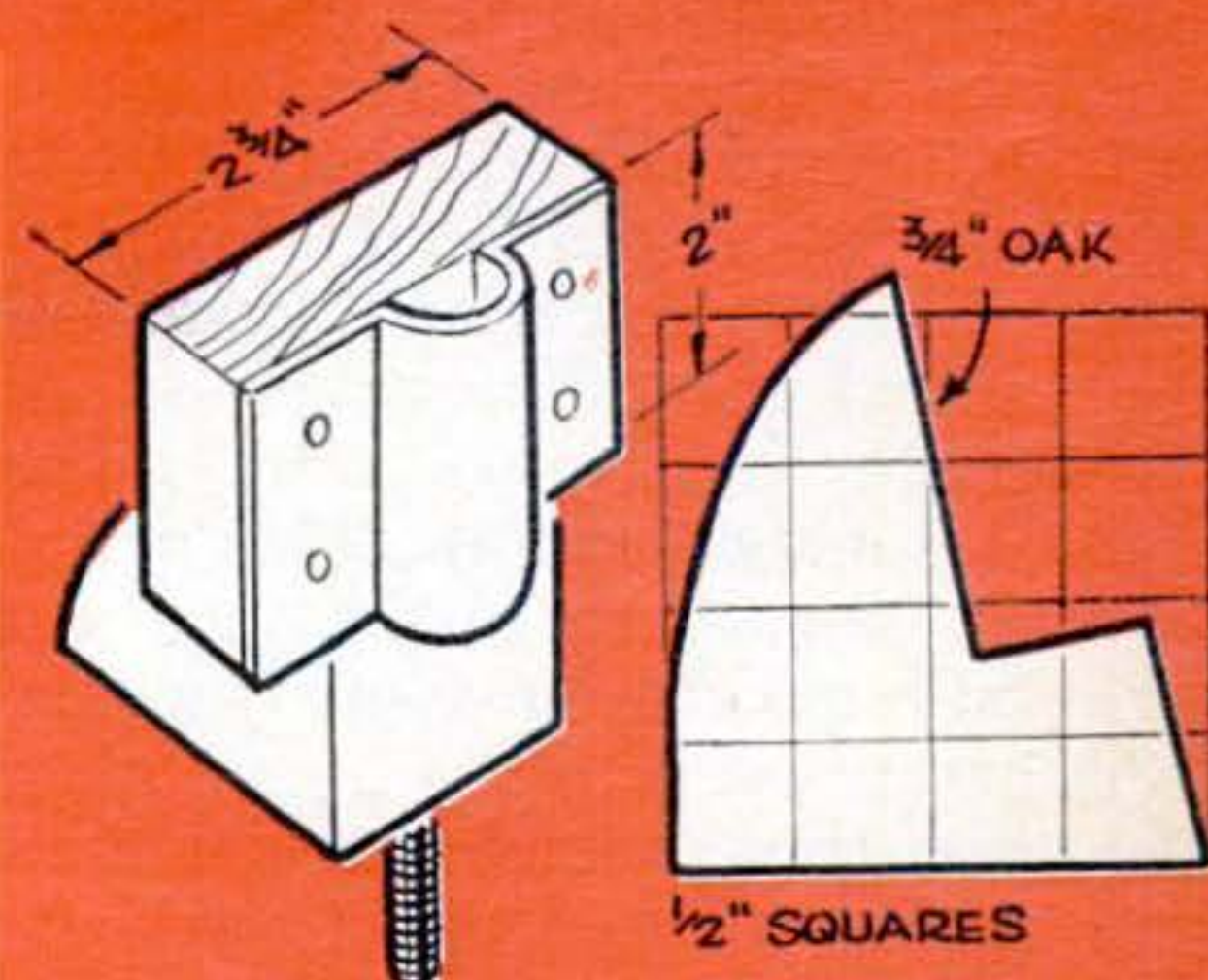
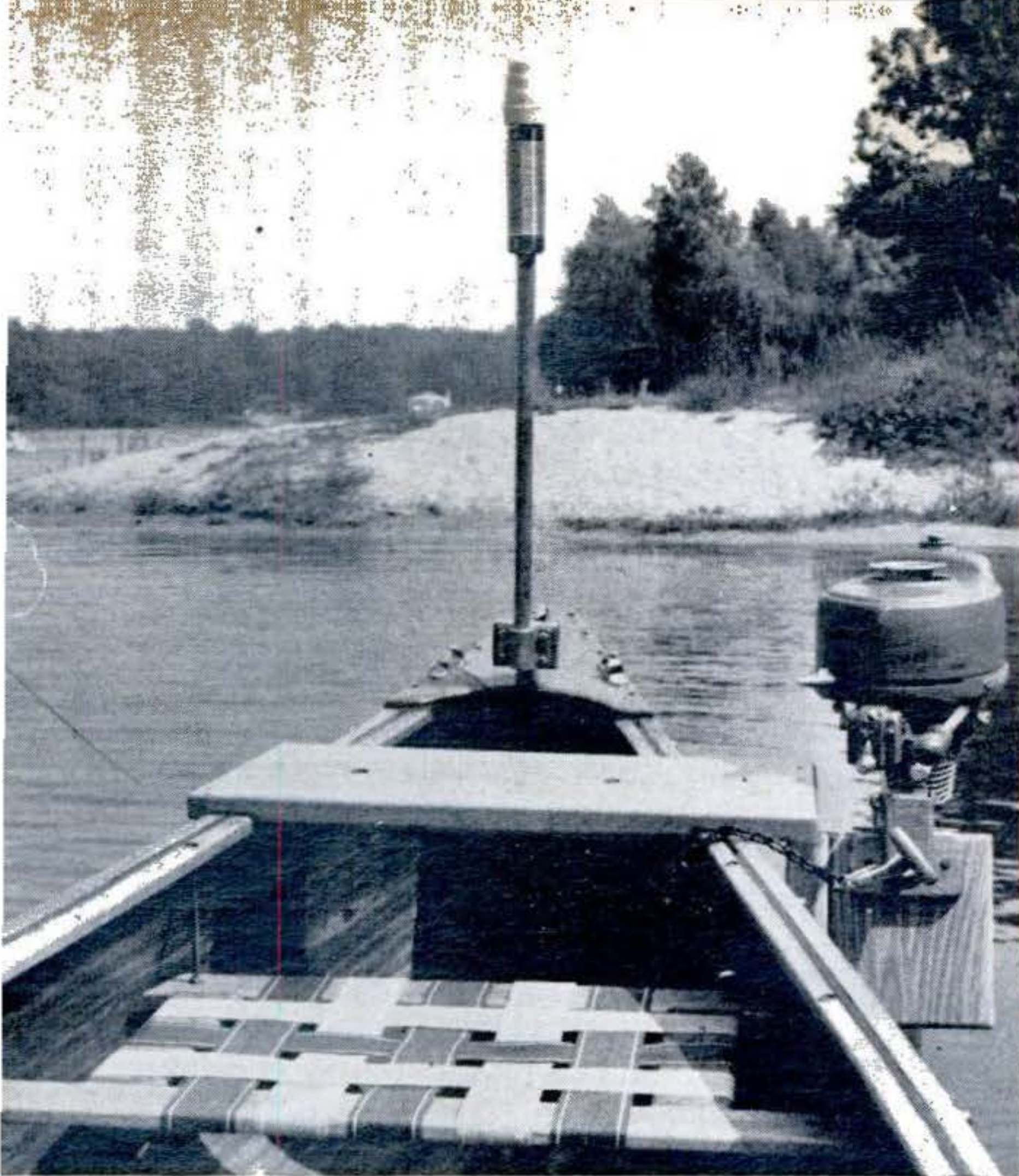
You can use the washer in a bathtub or shower as well as the dark-room sink. Through most of the year you might also use it outdoors, near any hose connection, where the water can perform a good second function by irrigating a lawn or flower bed.

For the frame, you need three 90-degree elbows, four tees, and three caps, all sweat fittings. Clean each joint with steel wool, wipe with flux, and heat the assembly with a propane torch until solder is drawn into the metal-to-metal joint.

To reduce soldering, cut the box from one large piece of thin-gauge sheet metal. The drawing gives layout dimensions. Bend up the sides and ends, and then solder the tabs at the four corners. Solder on rocking pivots in the exact center of the box. After completion, apply a couple of coats of paint to the sheet metal to prevent the possibility of rust.

Control rocking speed by varying the flow of water at the faucet.

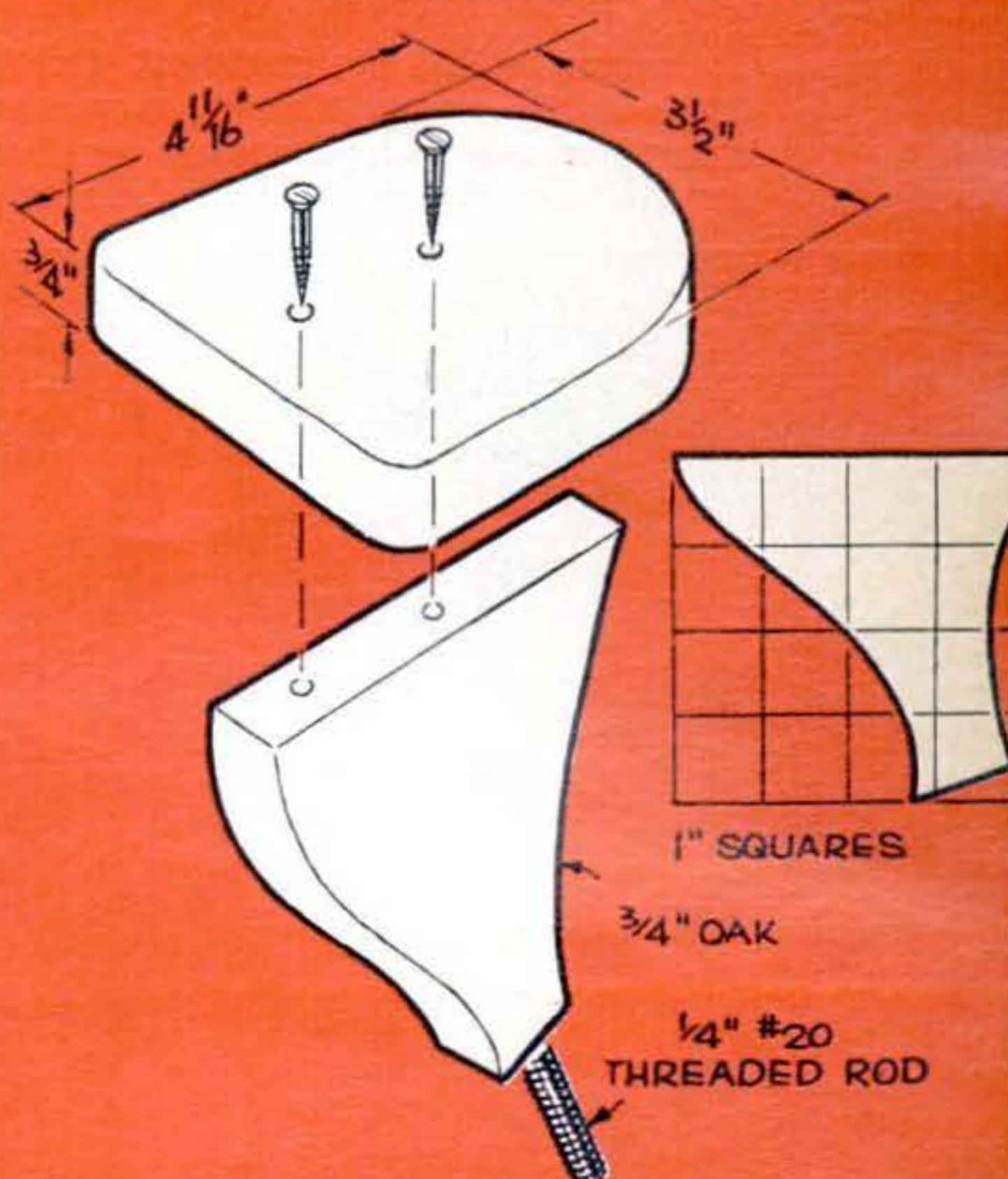




Outboard bracket and stern running light that you can add to a canoe are shown in the photo at left. A bracket for mounting the light can be assembled from two pieces of wood as shown in sketch above.



Elevated bracket raises bow light above the up-sweep of the canoe bow and makes it clearly visible at night. Light is battery-operated. When not needed, lamp and bracket can be stored inside, out of sight.



How to Make a Good Canoe Better

A simple outboard bracket, brass keel, and running lights will do a lot for our prize redwood canoe

By ROBERT P. STEVENSON
Editor, Projects & Activities

That redwood canoe for which we published plans two and a half years ago—in March 1967—has proven to be a real prize project for many POPULAR SCIENCE readers. Not less than 5,000 builders have completed it. One of them, Dr. Carl E. Aronson, of Springfield, Pa., writes:

"I found it to be an exceptionally stable and comfortable craft. Doing the work on evenings and weekends, it took me one and a half months to complete, at a cost of about \$150."

Continued

Like Floyd McGuckin and Jack Payne, the builders of the prototype, Dr. Aronson formed the hull by gluing together $\frac{1}{4}$ " strips ripped from 1"-by-18' redwood planks—an old boatbuilding technique.

After completing the craft, Dr. Aronson added several accessories. All of them could be adapted to any canoe:

A motor bracket. This was designed to fit just astern of the rear seat, and was built mostly of five-quarter oak. The main exception is a $2\frac{1}{2}$ "-wide clamping strip that runs crosswise under the gunwales—it was a piece of 1" oak left over from the original canoe construction.

Bracket parts were joined with waterproof resorcinol glue, secured with $1\frac{1}{2}$ "-No. 8 brass wood screws, countersunk and

covered with plastic wood. Edges were rounded and all surfaces sanded well before application of two coats of marine spar varnish. Felt was glued into the gunwale slots to avoid any damage to the finish of the canoe.

Bow and stern lights. On Dr. Aronson's canoe, the lights have self-contained batteries. Bracket parts were cut from $\frac{3}{4}$ " oak and finished with two coats of spar varnish. After pilot holes had been drilled, $\frac{1}{4}$ "-No. 20 threaded brass rods were dipped into glue and screwed into the bases of the two brackets.

The finished brackets were attached by inserting the threaded rods through holes drilled in the breastplates. They were secured from below with a washer, lock washer, and nut.

A brass keel. Adding one to the original canoe is well worth the effort and expense, Dr. Aronson reports, for it both improves the canoe's appearance and gives protection against rocks.

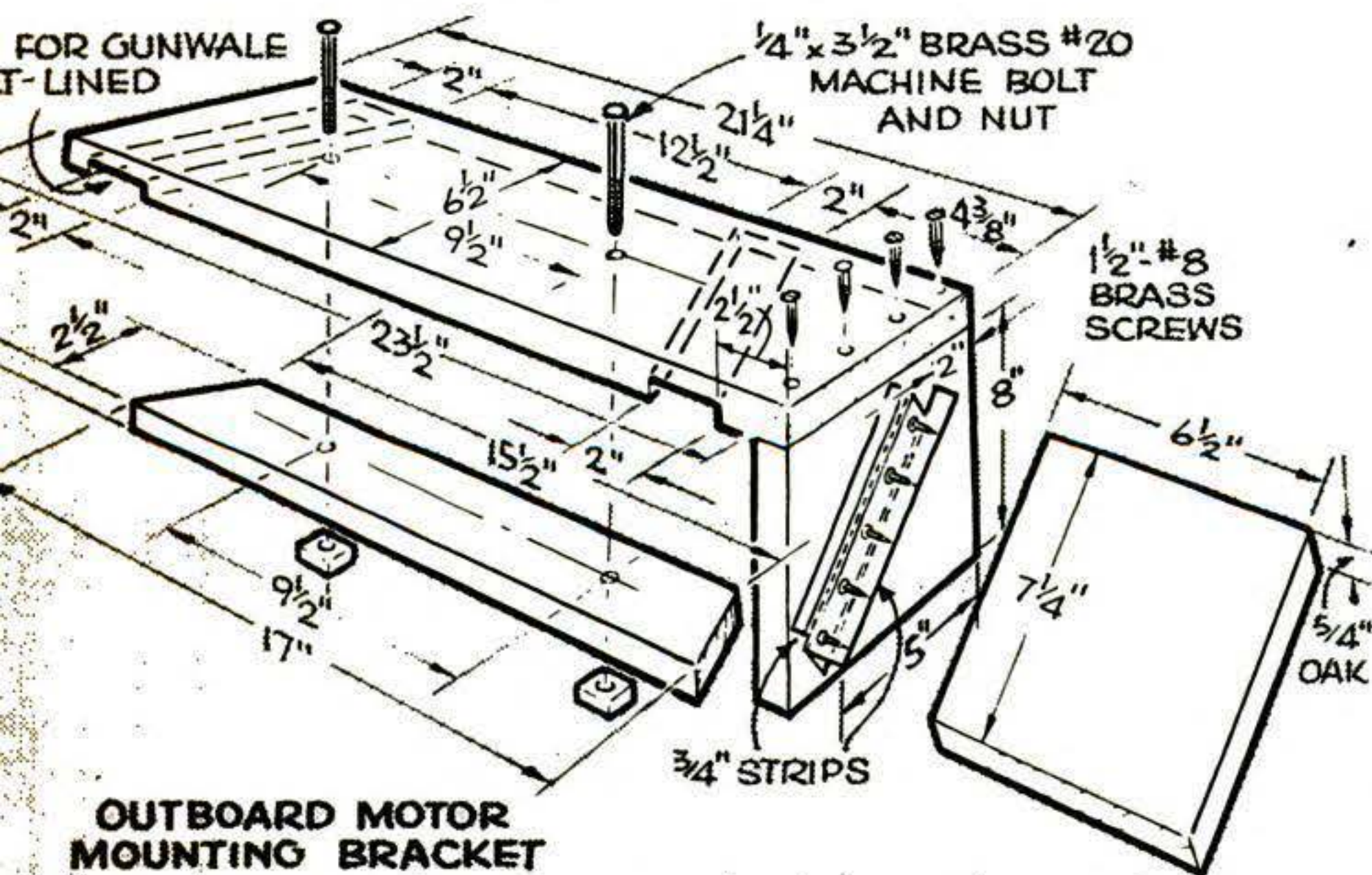
Two 12-foot lengths of $\frac{3}{8}$ " half-round brass stock were required. After allowing sufficient overhang at each end for the curvature of the bow and stern, position the brass, and drill and countersink it at about 12" intervals for $\frac{3}{4}$ "-No. 8 flathead brass screws.

Fasten the brass to the oak keel, then bend the strip to conform to the contour of bow and stern. Hold the brass against the hull and drill pilot holes into the fiberglass.

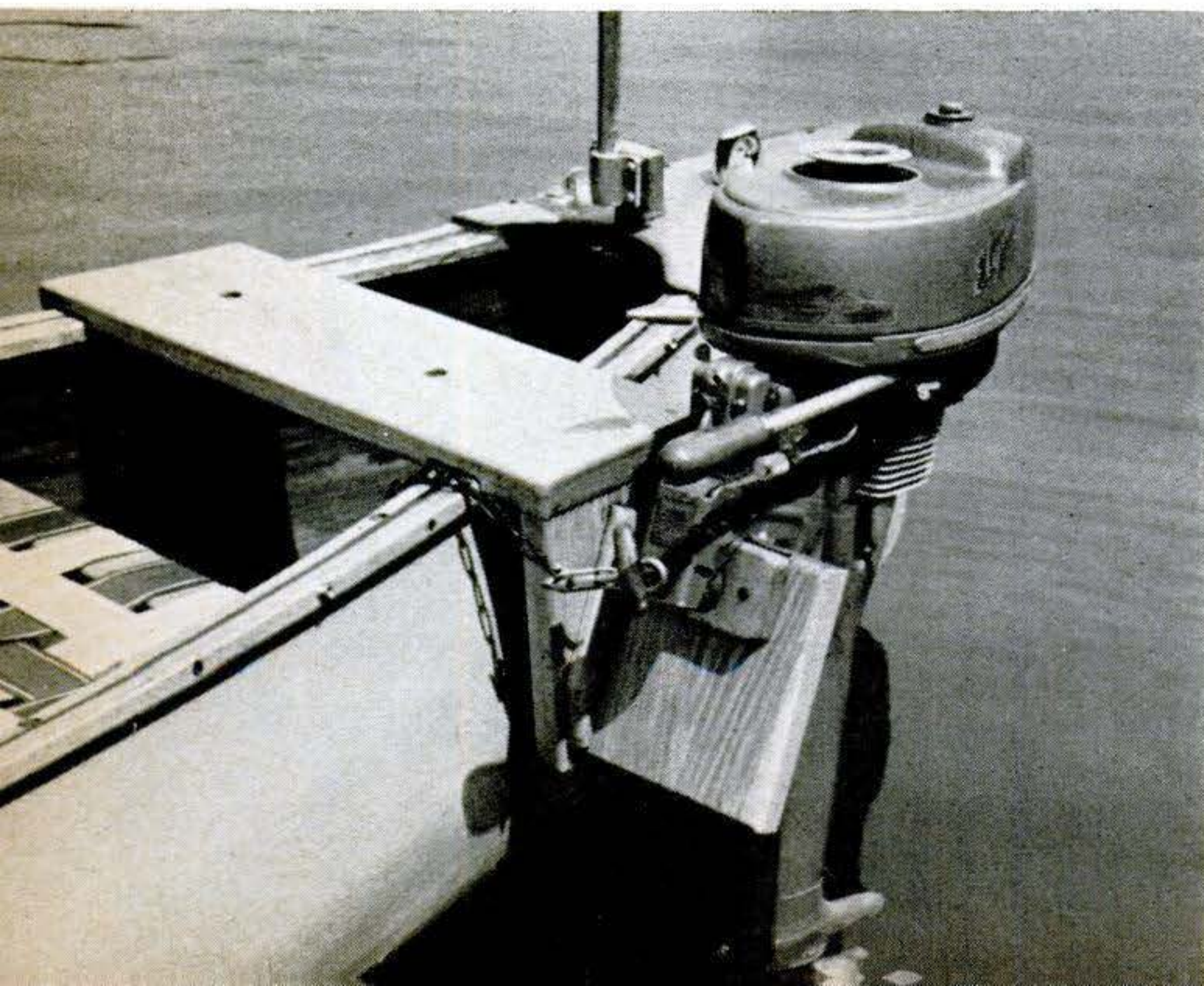
Mate the brass keel to the hull with reinforced fiberglass putty, where necessary, and epoxy (Dr. Aronson used Marinetex epoxy). Sand the epoxy to blend into the hull. Paint the exterior of the canoe with marine epoxy paint if desired.

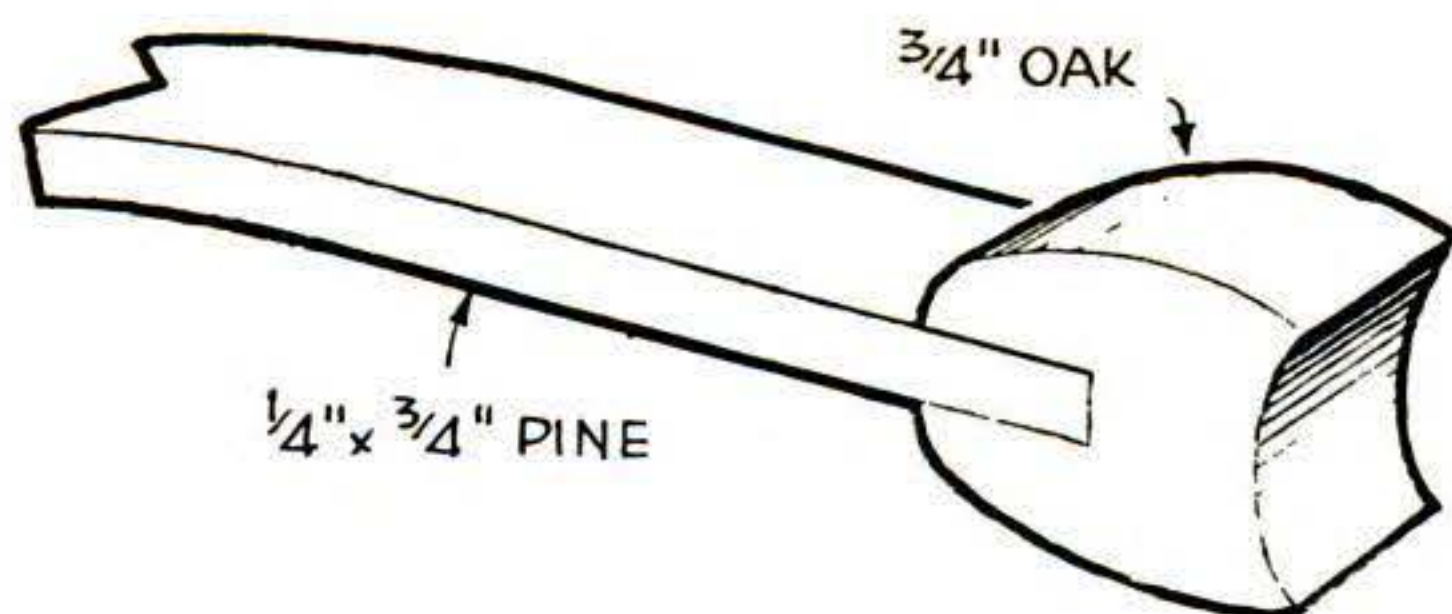
Tips for building the canoe. Dr. Aronson found an electric glue gun speeded up gluing the wood strips for the canoe. He also substituted copperplated weather-strip nails ($\frac{3}{4}$ "-No. 17) for nailing the strips to the stems, finding these have greater holding power than wire brads.

Once each set of strips was



To mount a $1\frac{1}{2}$ -hp. outboard, Dr. Aronson glued a small block to the angled bracket, as you see in photo below, but this piece may not be needed for other motors. The bracket for the stern running light can be seen in place beyond motor.





You can make a protective cover for your canoe from 5½ yards of 45"-wide leatherette. Make four cross-support bows as indicated in sketch to snap between the gunwales. With these bows in place, place material over canoe and mark it by running chalk along edge of gunwales. Spread flat on floor. In cutting, allow about 2" extra material for hem. Fasten cover with boat snaps at 12" intervals along gunwales.

firmly nailed in place, a C clamp was positioned as close to the tip of the strips as possible and a small amount of pressure applied. The electric gun was then used to force hot glue between the ends of the strips and stem. The clamp was then turned up snug. Since this glue sets quickly, it was necessary to leave the clamp in place only three or four minutes.

Using this method, it is possible simply to alternate ends of the canoe and keep working, eliminating setting up the clamp-



ing jig that must remain in place overnight when resorcinol glue is used.

The plans call for building the canoe on a form (or jig) of two-by-fours. Dr. Aronson mounted his jig on six two-inch casters so the project could be rolled out of the way while he wasn't working. When the job was finished, he mounted atop this jig scrap pieces of ½" plywood left from cutting the mold frames. The inner curves of these scraps provided a ready-made cradle for storing the canoe. **PS**

REDWOOD CANOE ...a beauty you can build

You might encounter the twin of this handsome 16-foot canoe anywhere in the U.S. A flotilla of 5,000 like it are now afloat.

That's a lot of canoes. But it's a safe prediction that before long there will be many more. The reason: Separate plans for building the canoe are now available—for the first time. They are based on plans that appeared with the first article about the original canoe (PS, Mar. '67).

You build the canoe from thin strips ripped from wooden planks—redwood, Philippine mahogany, or other suitable wood. You coat the hull with fiberglass. Total weight is around 70 pounds. Costs may range from \$100 to \$150.

Complete instructions come with the new, larger-size plans. The price: \$3.95. Allow up to three weeks for their delivery after you order them.



Fill out the coupon below and send it with \$3.95 in personal check or money order to:

Popular Science Plans (B-2)
355 Lexington Avenue
New York, N.Y. 10017

Enclosed is \$3.95 for one copy of your new plans for the Redwood Canoe.

Name _____

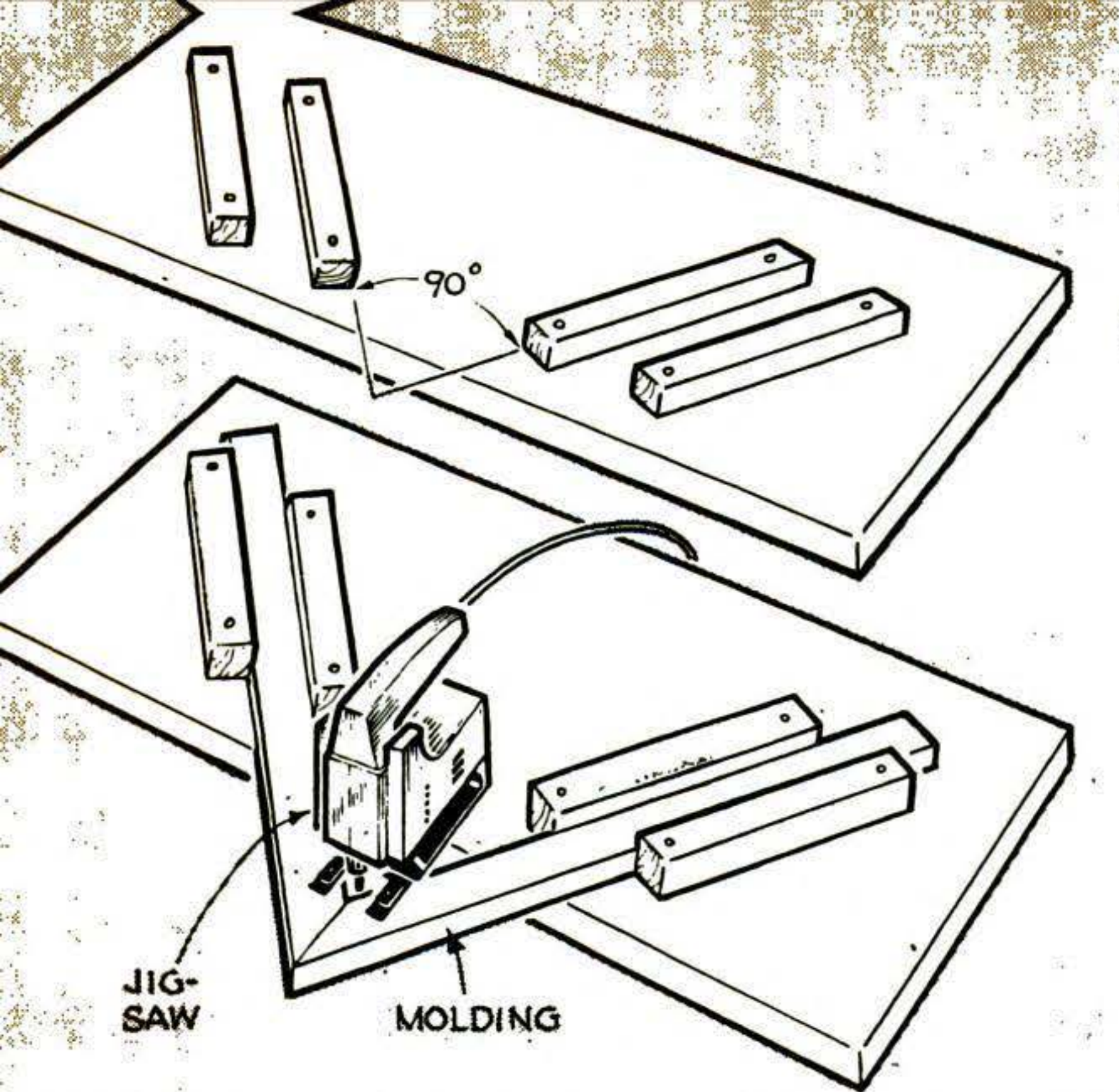
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City _____ State _____ Zip _____

3 Smart Shop Tricks

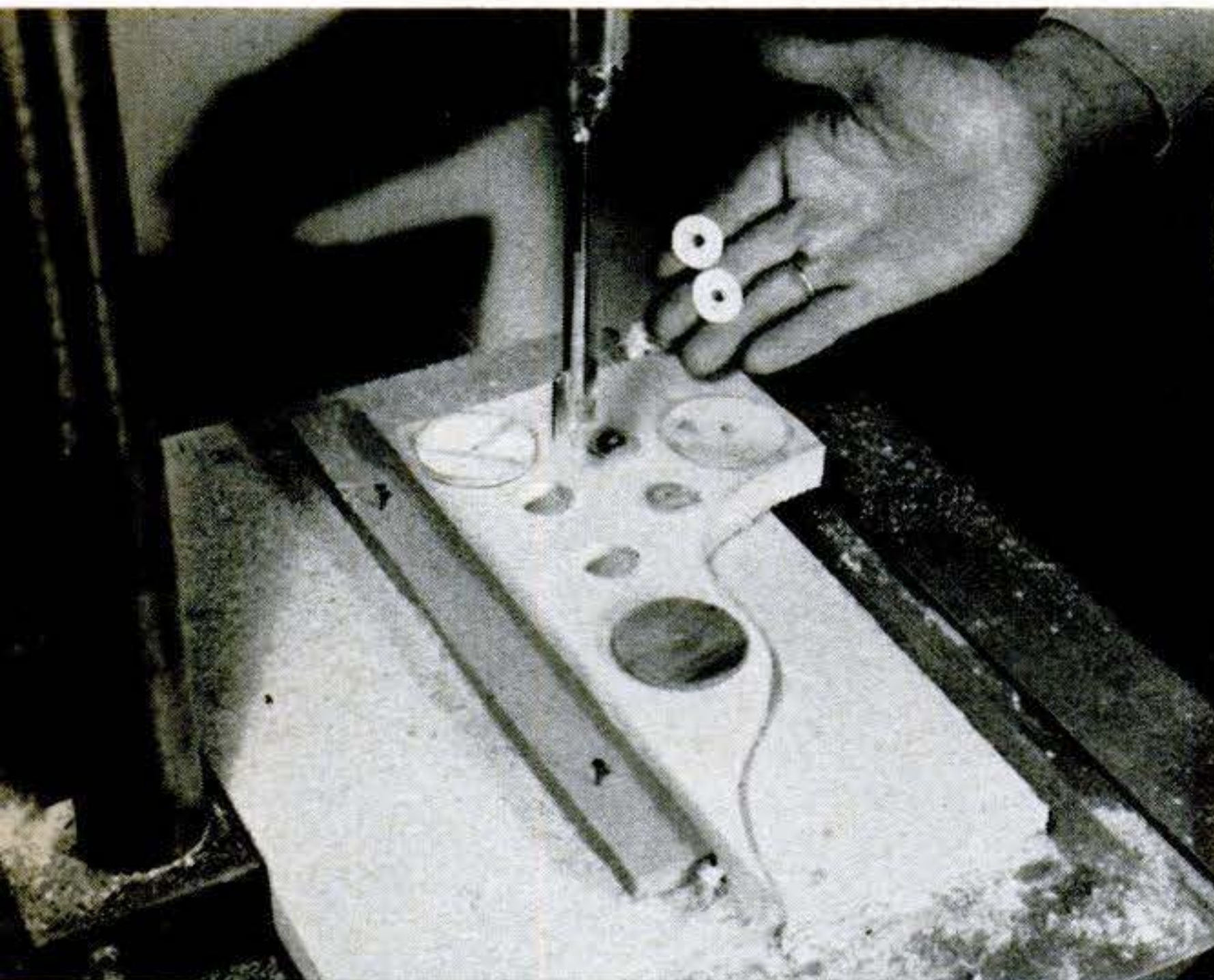
How to true up a miter joint

Here is a neat trick for getting a right angle in molding without the fuss of perfectly mitered corners. Nail up scrap wood to make a jig like the one in the upper drawing. After cutting the ends of the molding to approximately 45 degrees, place them together as shown and run a jigsaw (or hacksaw) through the crack. Then move the pieces closer together and make another cut. Even if the cut isn't perfectly straight, the slight wiggles in each piece will match and the joint will be perfect.—*Hugh Lineback*.



Spade bits can cut model wheels

You can use spade and multispur bits for cutting thin wheels for models and toys. Bore through a piece of hardwood on the drill press until the point of the bit comes through. Then finish drilling from the other side—and you have a wheel with a center hole. A fairly fast speed on the tool will produce the smoothest wheels.—*C. Wayne Close*.



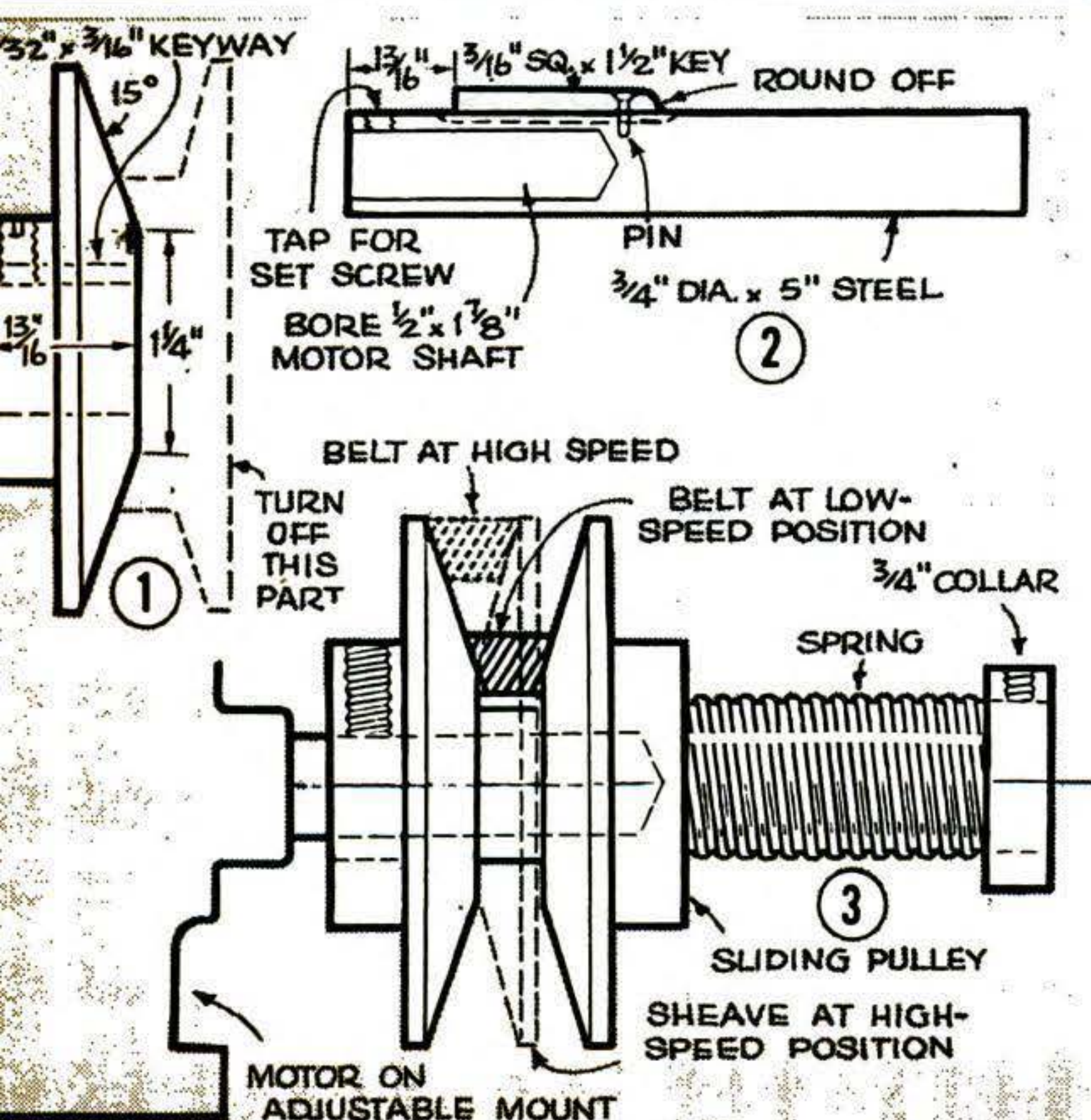
How to make a variable-speed pulley

This pulley shifts speed by changing its belt diameter between 2" and 3". As the motor on which it's mounted is moved away from the driven pulley, one flange is forced back, dropping the belt to a smaller diameter. Moved nearer, the pulley closes, forcing the belt higher. The motor must be on a tilting or sliding mount.

Get two 3" cast-iron pulleys for a $\frac{3}{4}$ "-diameter shaft, with hubs and keyways. In a lathe with the compound rest set at 15 degrees, machine away the part opposite the hub as shown (Fig. 1), extending the other flange to a diameter of $1\frac{1}{4}$ ".

Bore out a 5" length of $\frac{3}{4}$ " cold-rolled steel to fit the motor shaft (Fig. 2). Cut a keyway and pin in a key, on which one pulley section should slide freely. Tap a hole through to lock the other on the shaft.

A fairly heavy compression spring about 6" long is needed (Fig. 3). The original one was made of 8' of spring-brass control-cable wire, wound at the rate of four turns to the inch.—*Stanley C. Battles*.

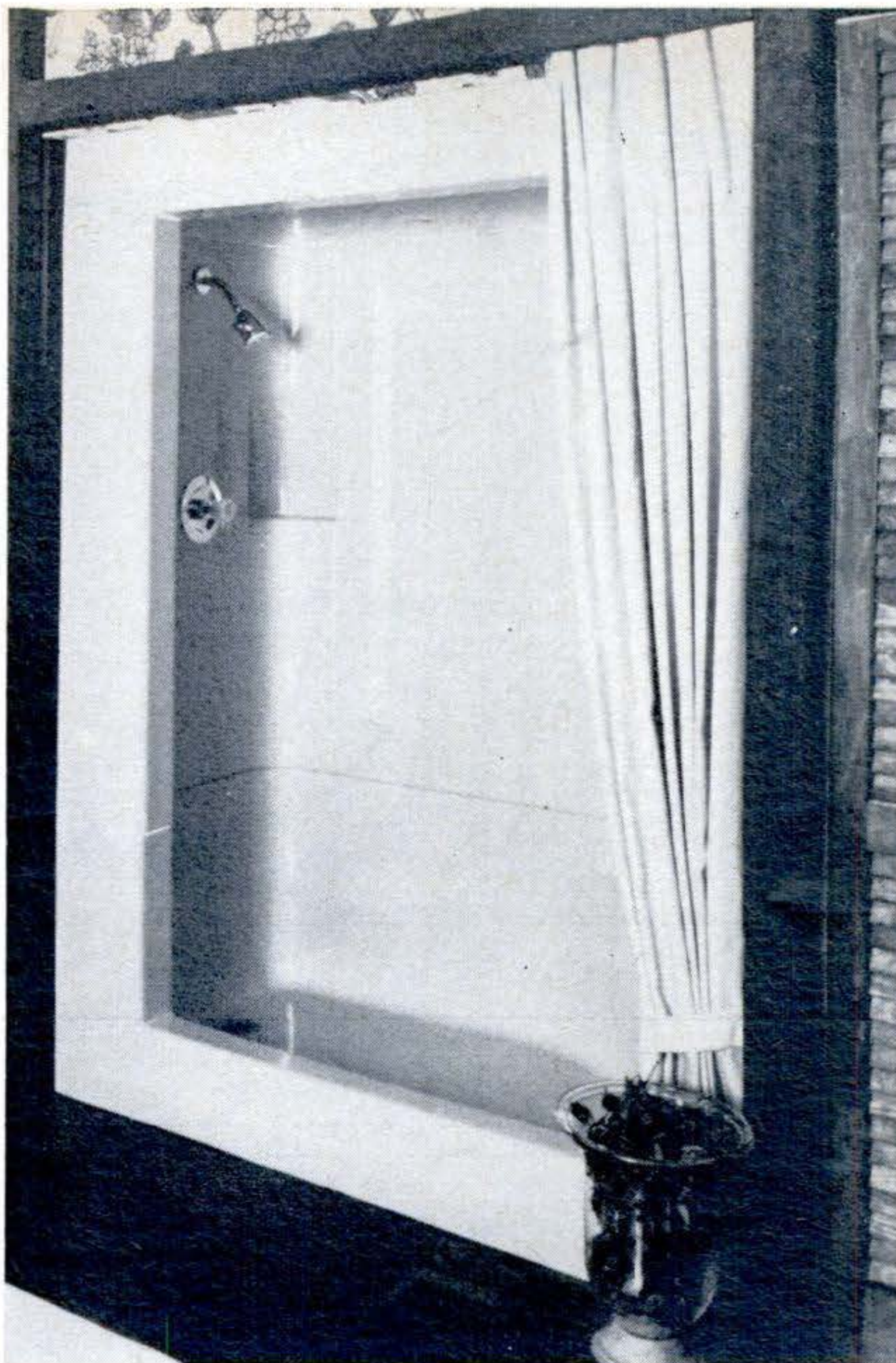


For Remodelers: A Bath Unit that Comes in Pieces

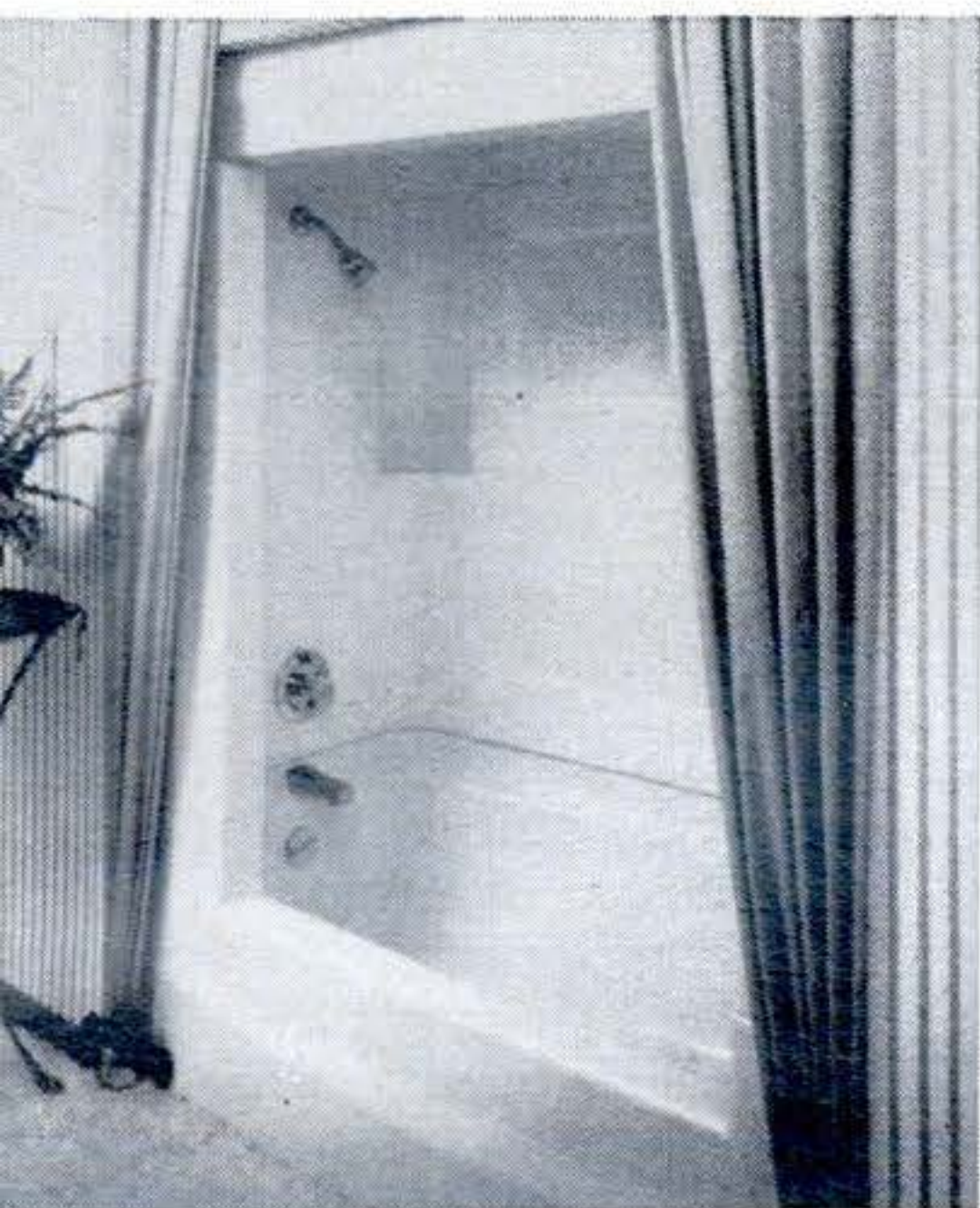
The truckman delivers three cartons to your house. You pick up the first one and head toward the bathroom.

"What's that?" your wife asks. "Our new shower," you say, picking up the second carton.

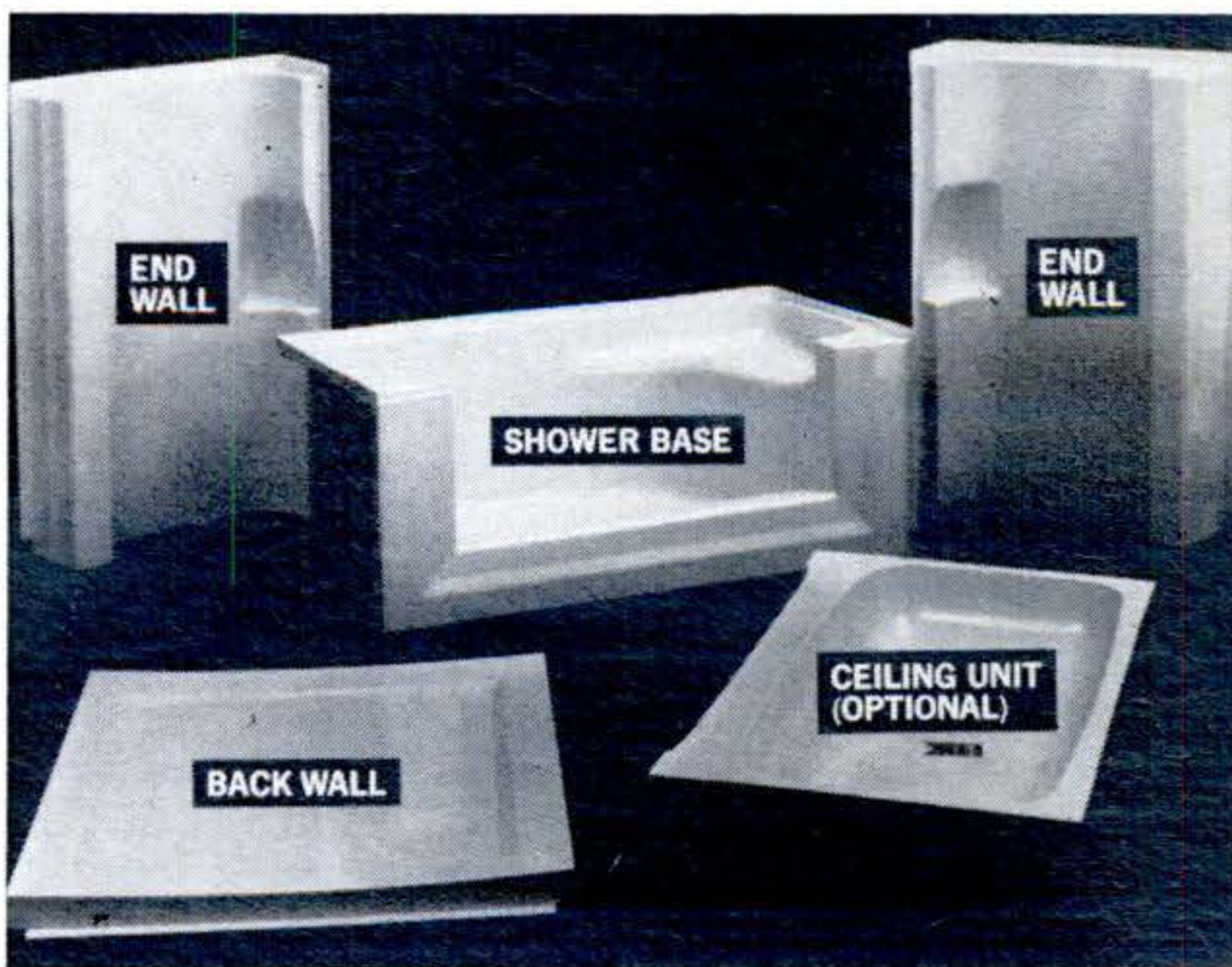
That's how Universal-Rundle's fiberglass shower and bath units come. U-R is now making them available to do-it-yourselfers, in addition to the building trade. Total weight of the four sections you need for a Combobath or Comboshower: 135 pounds. The light weight enables you to handle all work yourself—no assistants needed. Because the units come in sections, you can take them through any doorway—a boon to remodelers. Sections screw to mounting strips and lock together, with a bead of caulk to ensure watertightness. Naturally, there's no tiling—another boon.



Comboshower unit, shown installed, is five feet long, 34 inches deep, 80 $\frac{5}{8}$ inches high. In white, the unit sells for about \$375. Optional ceiling section adds about \$75 to the cost.



Combobath differs from shower unit only in base. Units are made by Universal-Rundle, 217 N. Mill St., New Castle, Pa.



Standard fiberglass sections, plus optional ceiling, are shown above. Besides white, units come in tan, green, blue, pink, and yellow. Colors cost \$25 to \$50 more than white.



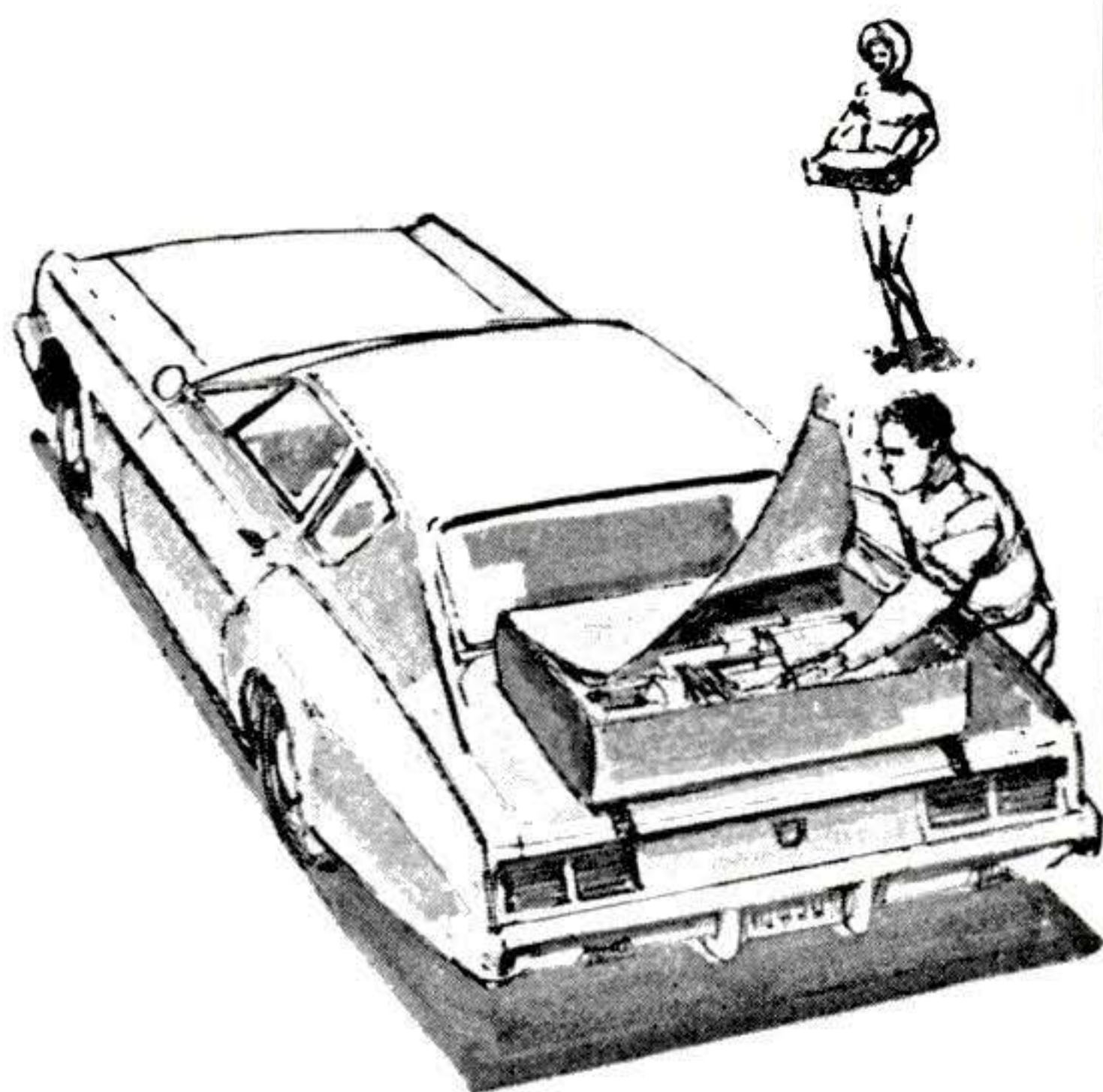
New Ideas from the Inventors

ILLUSTRATIONS BY
DANA RASMUSSEN

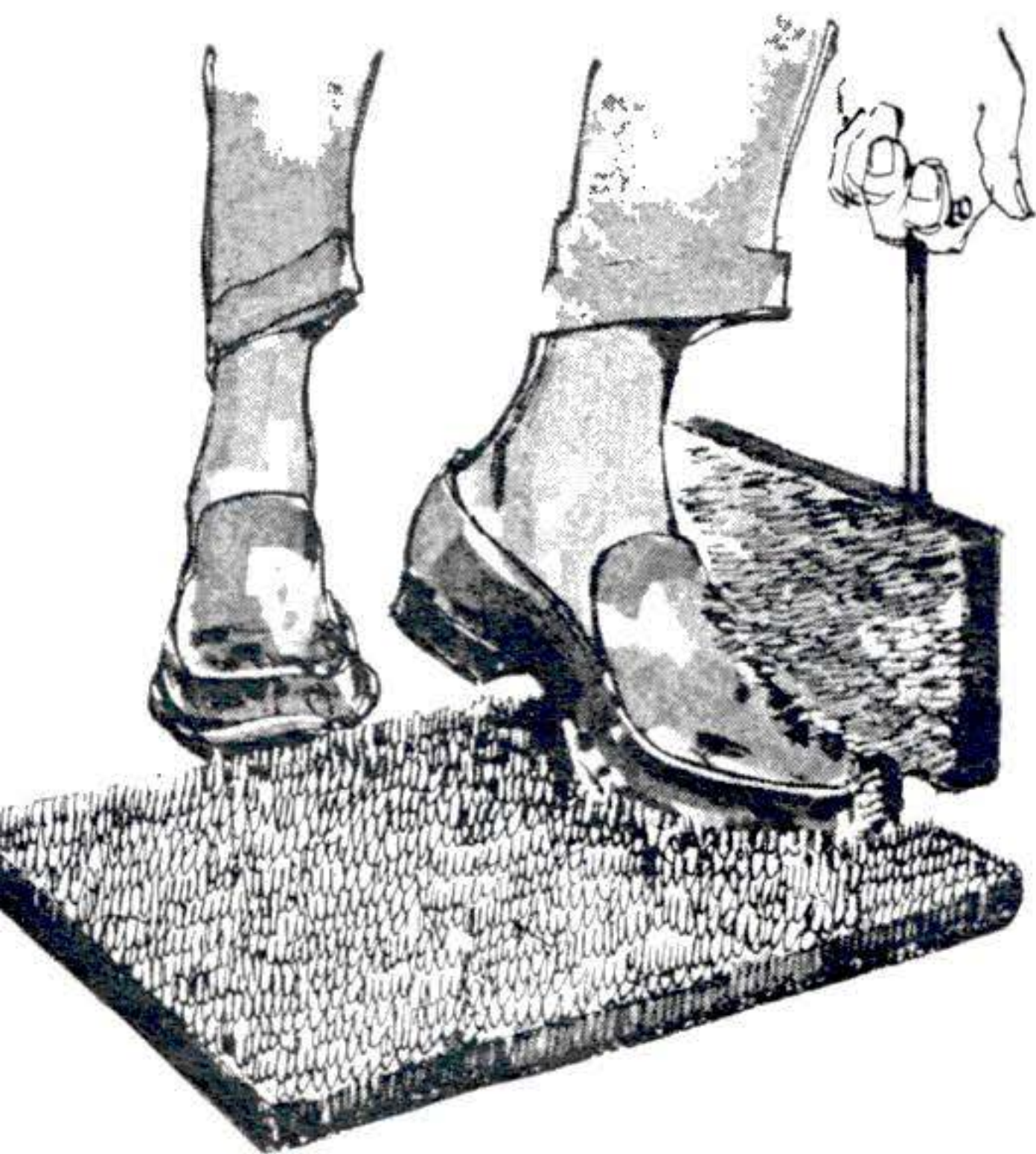
Catapult quiets jet roar. Assisted by a high-speed catapult, a jet plane might climb to several thousand feet with throttled engines, thus reducing near-ground noise. This United Aircraft patent would use air pressure to propel a piston through an under-the-runway cylinder. Yoked to the plane, the piston would catapult the craft to climbing speed before disengaging.



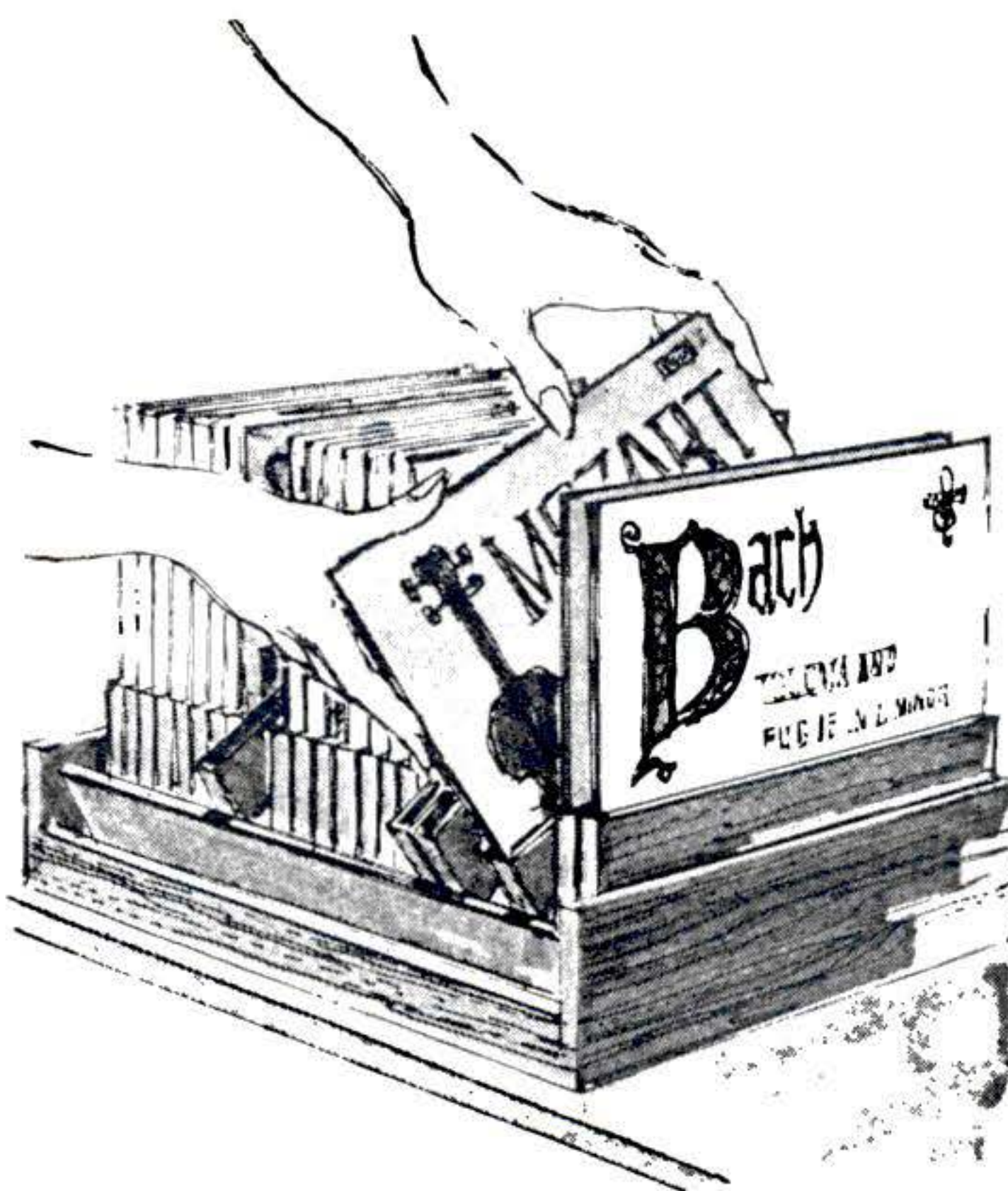
Paddle doubles as flare gun. A stranded hunter or boatman would be better able to summon help—or defend himself—in an emergency if he carried an oar or paddle like this. One end of the hollow metal handle would contain a firing mechanism and a fitting for a flare (or shotgun) shell. To fire, he'd unscrew the paddle and handle cap, then strike the pin against any hard surface.



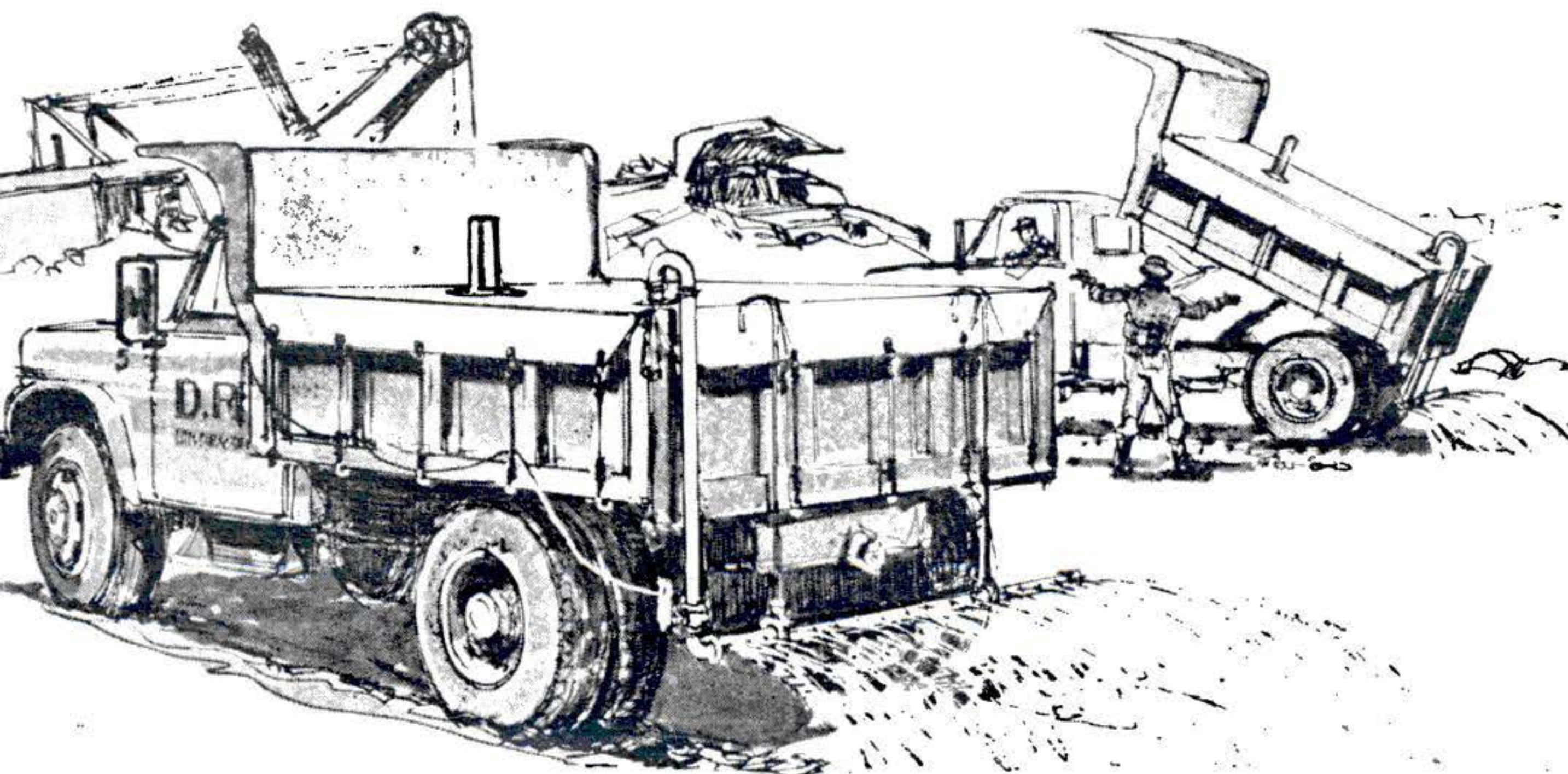
Trunk-top bag increases storage. Strapped to a trunk lid, this shallow zippered bag would provide extra space for your travel gear without preventing normal access to the car trunk. Made of a strong, weatherproof fabric or plastic, the bag could be unstrapped and carried away like an extra suitcase. When it wasn't needed it would fold up for easy storage inside the trunk or in the garage.



Lift mat wipes shoe sides. Hinged flaps on one or both ends of this doormat would make it easier to dislodge the mud or snow that clings to the sides and uppers of your shoes. A small handle projecting from the hinged flap would let you lift the flap with your toe. A slide extension of the handle would aid in easier manipulation.



Record files tip out. Narrow sleeves pivoted on a common axis would let you tip records in or out of this rack to keep your discs in order, provide easier access, and help you find the numbers you want. Each holder would be weighted to remain in tipped-out position when empty and to retract automatically when the record was replaced.



Dump truck sprays liquid. A flexible bag could convert an ordinary dump truck into an effective spray wagon. The container could be placed in the truck bed and filled

through a stack. Liquid would then discharge itself by gravity through an outlet pipe. Adjusting the tilt of the truck body would prime and pressure the discharge.

The following patents have been issued on these inventions: **Jet catapult**—No. 3,428,273 to J. M. Tyler, Glasbury, Conn.; **Trunk stretcher**—No. 3,393,845 to L. Gilbreath, West Keansburg, N. J.; **Paddle flare**—No. 3,367,052 to L. E. Powers, Hazelwood, Mo.; **Lift mat**—No. 3,390,414 to I. H. Kravitt, Philadelphia; **Record rack**—No. 3,391,792 to M. Makar, Vancouver, B.C.,

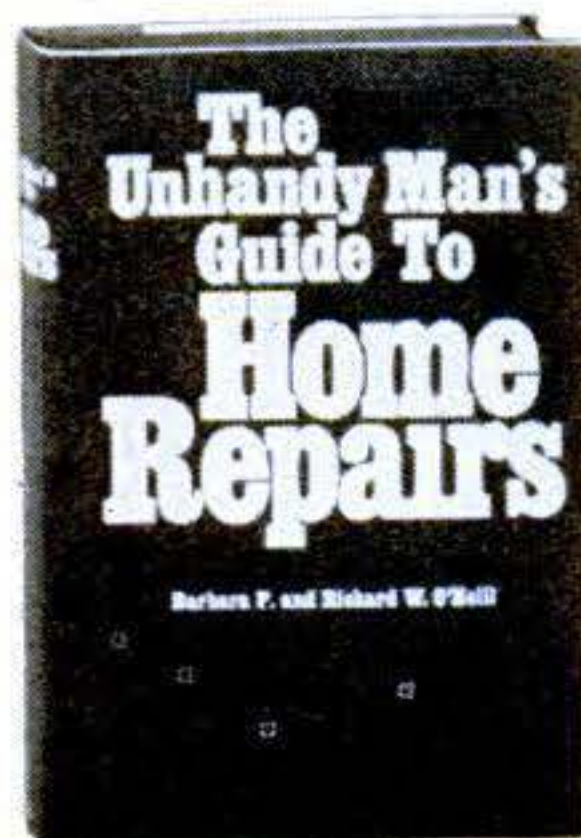
Can.; **Spray truck**—No. 3,393,835 to P. Kantor et al.; Memphis, Tenn.

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D. C. 20231, at 50 cents each. To write to an inventor, if the address above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

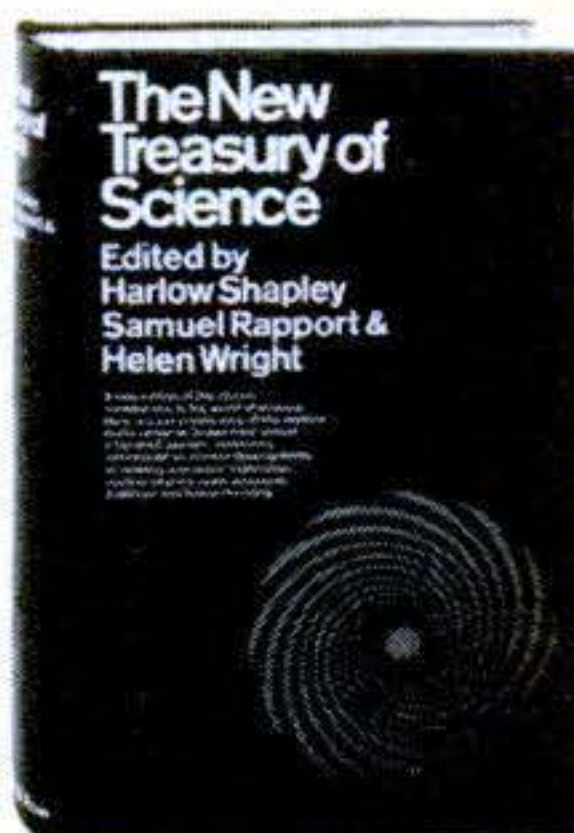
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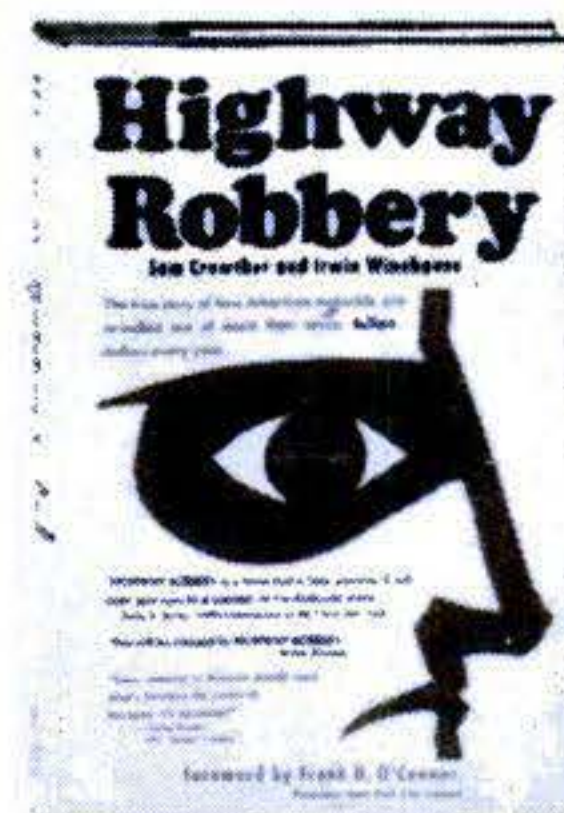
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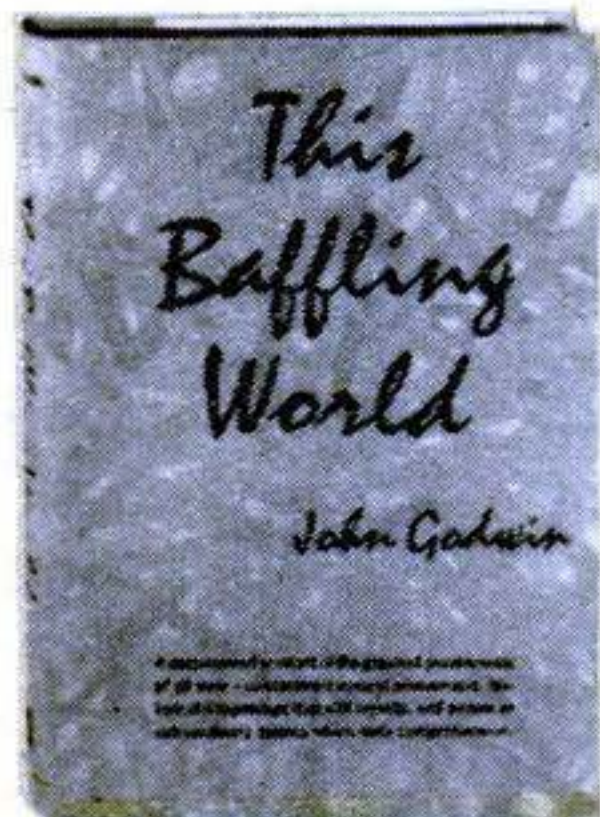
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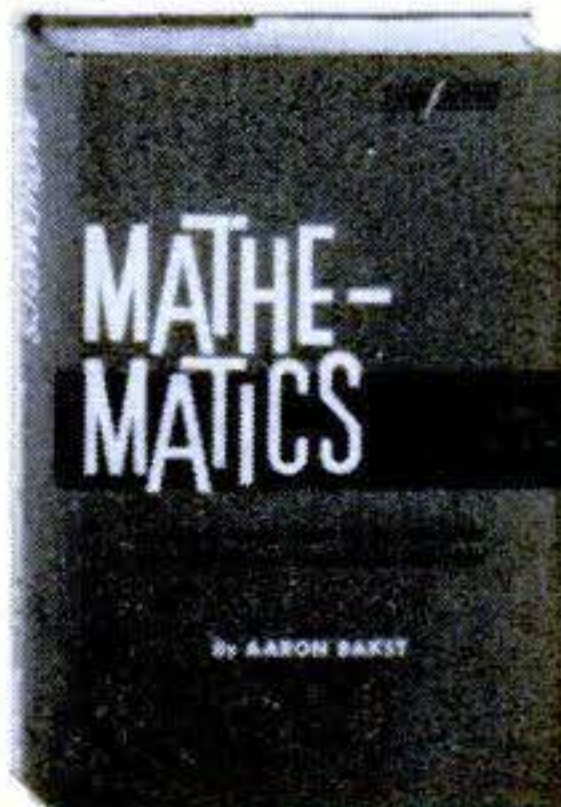
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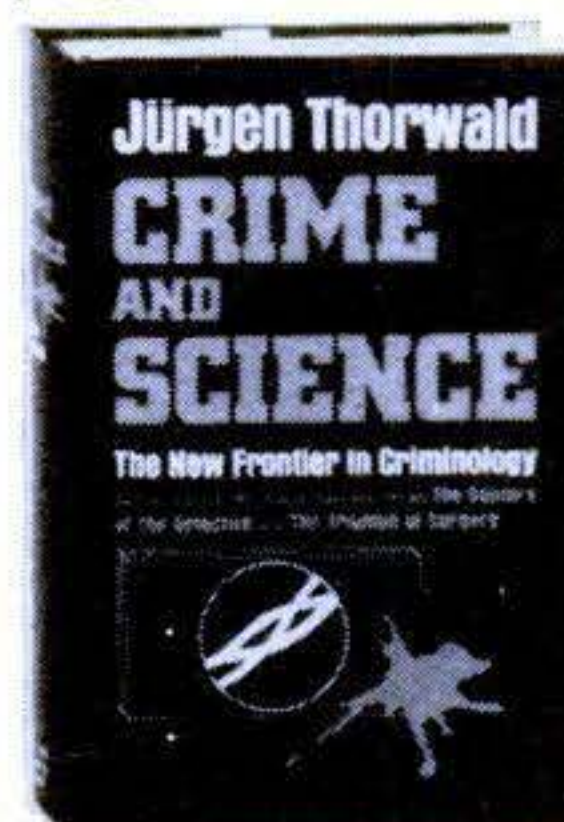
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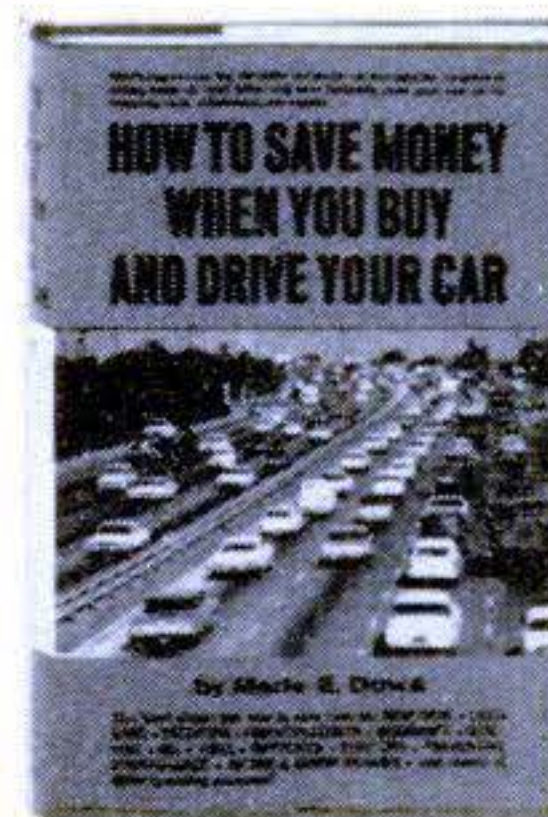
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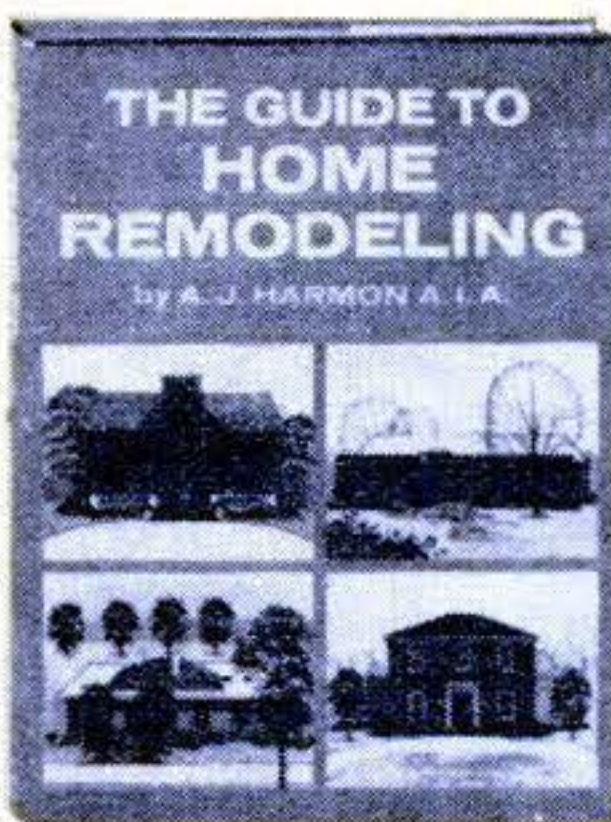
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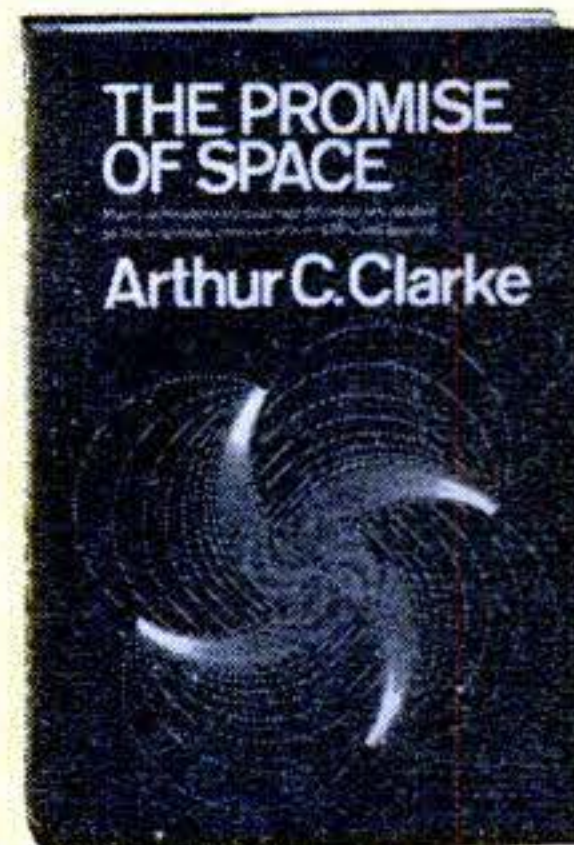
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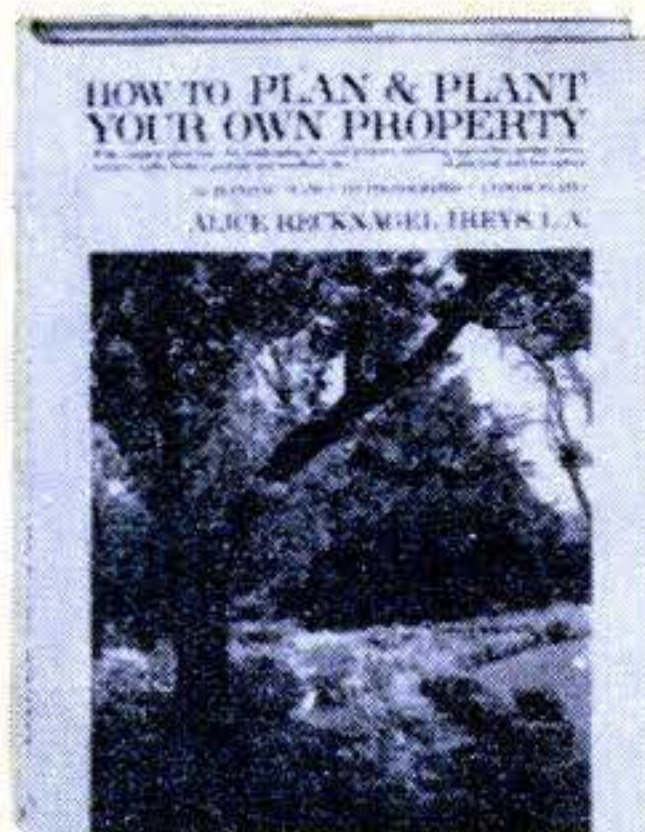
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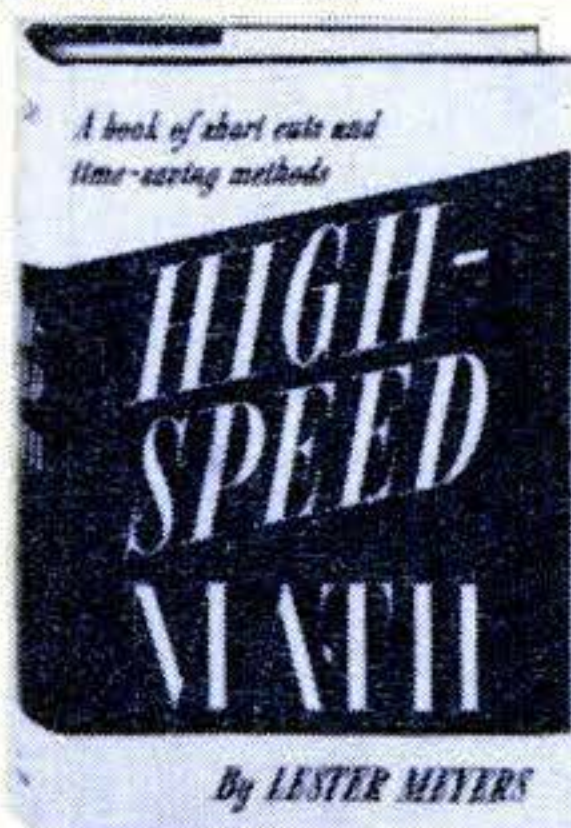
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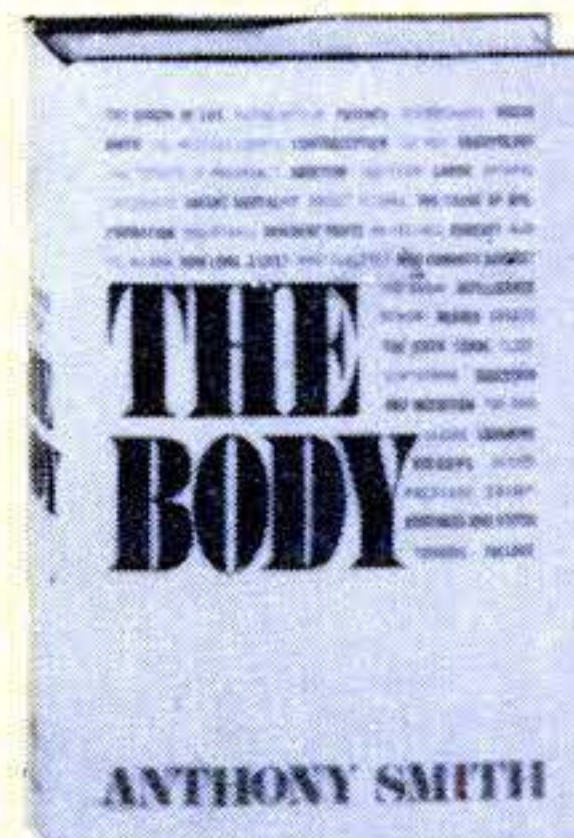
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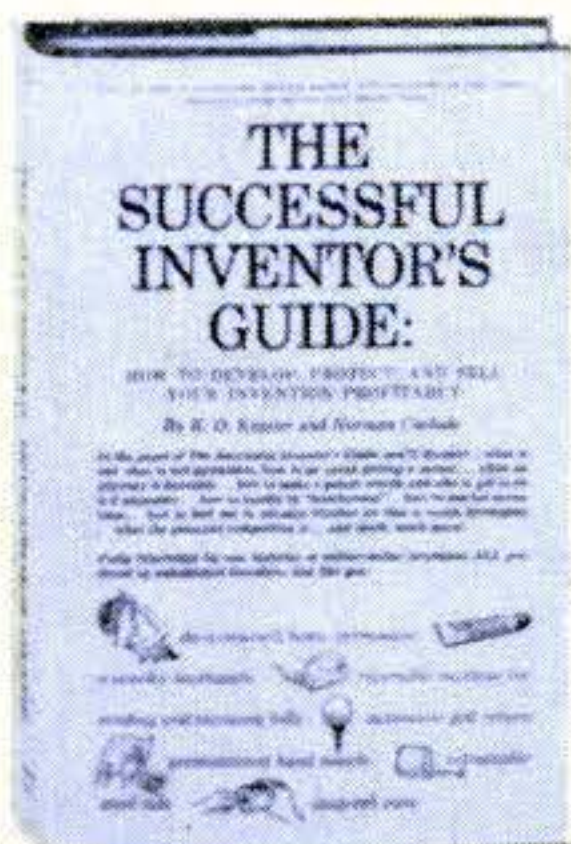
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Build Yourself the DELTA DESK



Named for the Greek letter formed by its triangular end (above), Isaacs' Delta desk is a companion piece to last month's I table and utilizes the cube chair detailed in that issue. Overhead view (below) shows neat, rational work layout of foldaway light, typewriter, and reference books. Drop leaf is supported on enameled steel angles. Between them is trough for storing pencils, envelopes.



By KEN ISAACS

PS Design Consultant

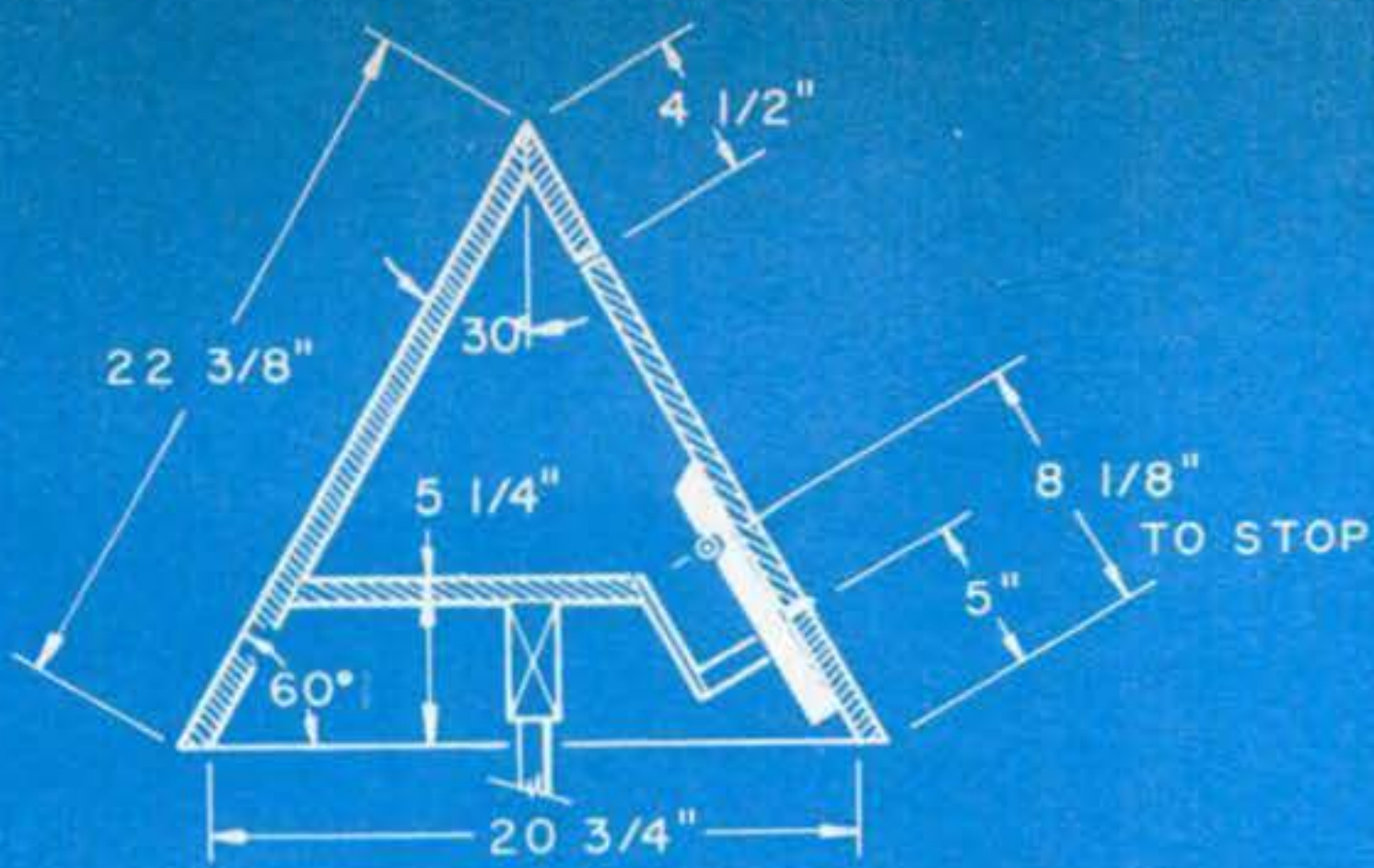
Here's another variation on traditional furniture design. Like last month's dining set, it's one of the small-scale furniture forms that I developed while working on the larger principles of my Matrix Idea and Living Structures. It brings to the long-popular drop-leaf desk a body shape that is a knife-edge prism in glowing color, set on a stand.

The swing-out lamp is ideally positioned for writing, yet tucks down and inside, like a swan's head under its wing, when the leaf is closed. The whole unit is a piece of useful sculpture.

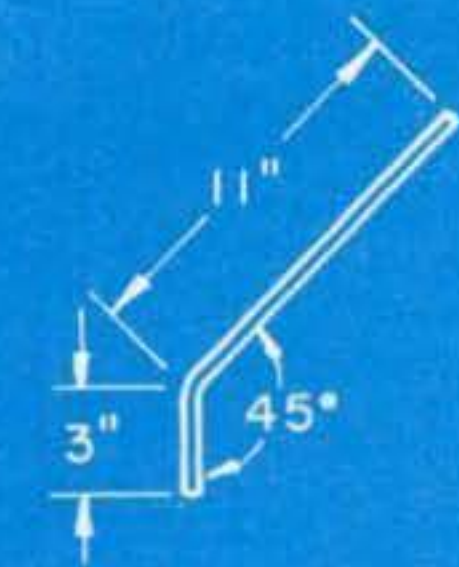
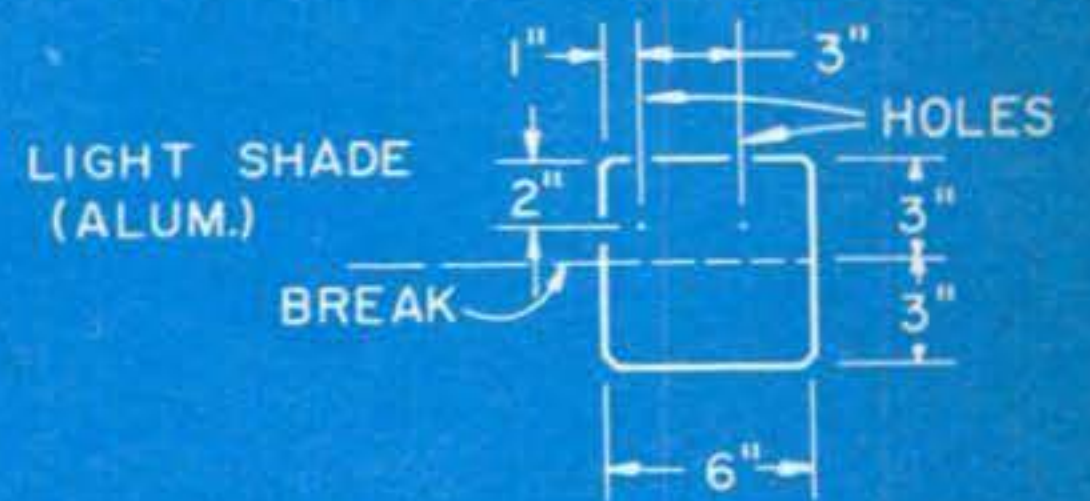
The finished desk can be ordered from my own store,
Continued

PS BLUEPRINT

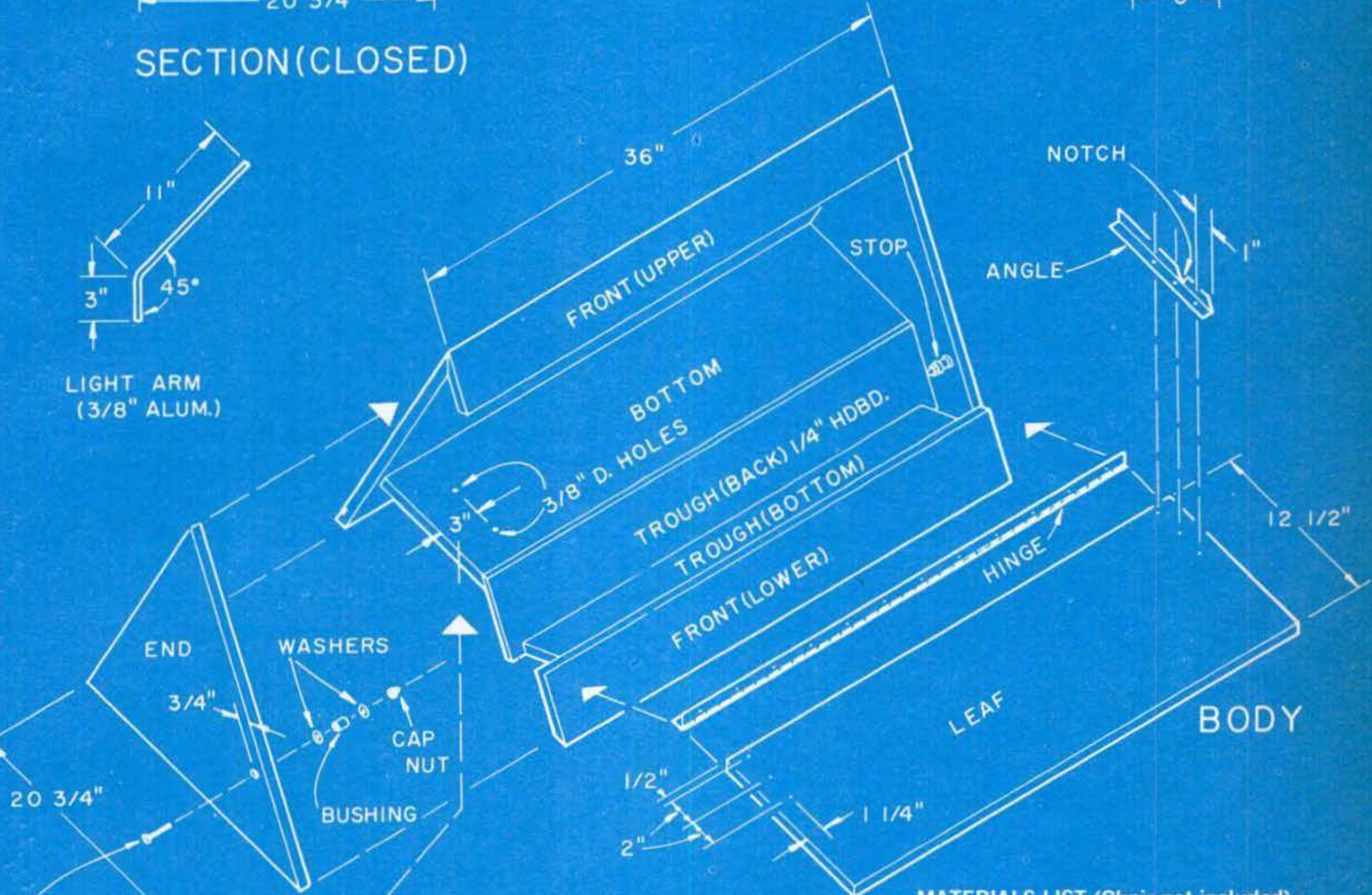
DELTA DESK



SECTION(CLOSED)



LIGHT ARM
(3/8" ALUM.)



MATERIALS LIST (Chair not included)

3/4" Plywood (1 ea. except where noted)

- 22 3/8" x 36" — back
- 19 3/8" (center height) x 20 3/4" — ends (2)
- 4 1/2" x 36" — front (upper)
- 12 1/2" x 36" — leaf
- 5" x 36" — front (lower)
- 11 3/8" x 34 1/2" — bottom
- 3 1/4" x 32 1/4" — trough (bottom)

1/4" Hardboard

- 4 1/4" x 34 1/4" — trough (back)

Two-by-fours

- 34 1/2" — beam
- 20" — feet (2)

Miscellaneous

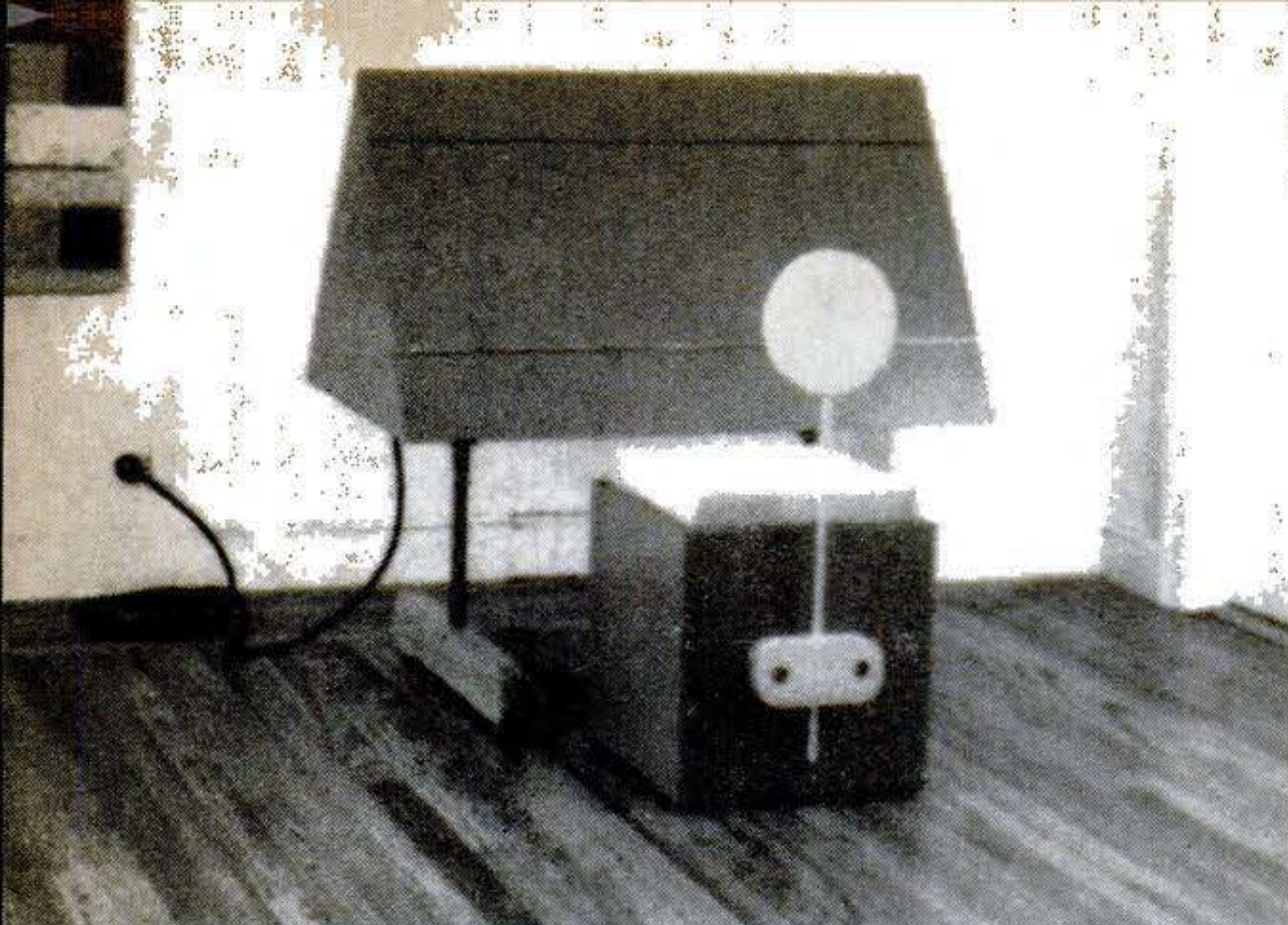
- 7/8" D. x 20" tubing — legs (2)
- 36" chrome-plated piano hinge
- 1/8" x 3/4"-sq. x 9" steel angle (2)
- #8 x 3/4" sheet-metal screws (6)
- 1/2" D. x 2" aluminum rod
- 1/4" x 1 3/4" plated FH bolts (2)
- 1/4" x 20 cap nuts (2)
- 3/8" D. x 15" aluminum rod
- socket and clamp
- 6" x 6" Reynolds sheet aluminum
- spring-steel broom clips (2)
- ball joint
- electric plug, 8 ft. electric cord
- magnetic catch, washers, wood screws,
- Pop rivets, glue

leaf
support

stops

light

BASE



Clean lines when desk is closed make it a piece of modern sculpture. Leg tubing can be cut to bring leaf to best writing or typing height for any chair; one shown here is storage cube detailed last month.

Groveland 2, 324 E. 73 St., New York, N. Y. 10021; but you can easily construct it in your home workshop.

Cut the ends first, after making sure your layout is accurate. These are the keys to the body assembly. When cutting the back and upper front pieces, set your saw to assure a tight top joint. Assemble these body pieces with glue and wood screws, then add the lower front.

Cut the beam for a snug fit between the body ends and drill the leg sockets in it and in the feet, making sure your bit is vertical. Sockets should provide a tight fit for the tubing, but you can pin the ends with a nail, if necessary. Attach dome glides to the bottom of the feet.

Screw the trough back to the angled front edge of the bottom, then glue and

screw this assembly to the top of the beam.

Insert the leg tubes in the foot sockets and slip the beam onto the top ends. If all checks out, cut the trough bottom and fasten with glue and screws to the back of the lower front. Fit the leaf and attach the piano hinge to the top edge of the lower front. Join the two assemblies with glue and screws.

Cut and notch the steel angles and screw them to the leaf, shimming with washers as shown below. The angle specified will support a light portable typewriter. If you'll be using a heavier machine, go to 1"-square angle and notch the free ends to fit the stop bushing for positive indexing. (The notch shown below is to clear the stop when leaf is closed.)

To make the bushings, drill a $\frac{1}{4}$ " hole through the center of the aluminum rod, then cut it in half and square the ends with a file. Locate the holes for the stop bolts carefully, checking against the action of the leaf bracket before drilling through each end panel. Countersink the holes on the outside for flathead bolts. Assembly screws, too, should all be set below surface, covered with wood putty.

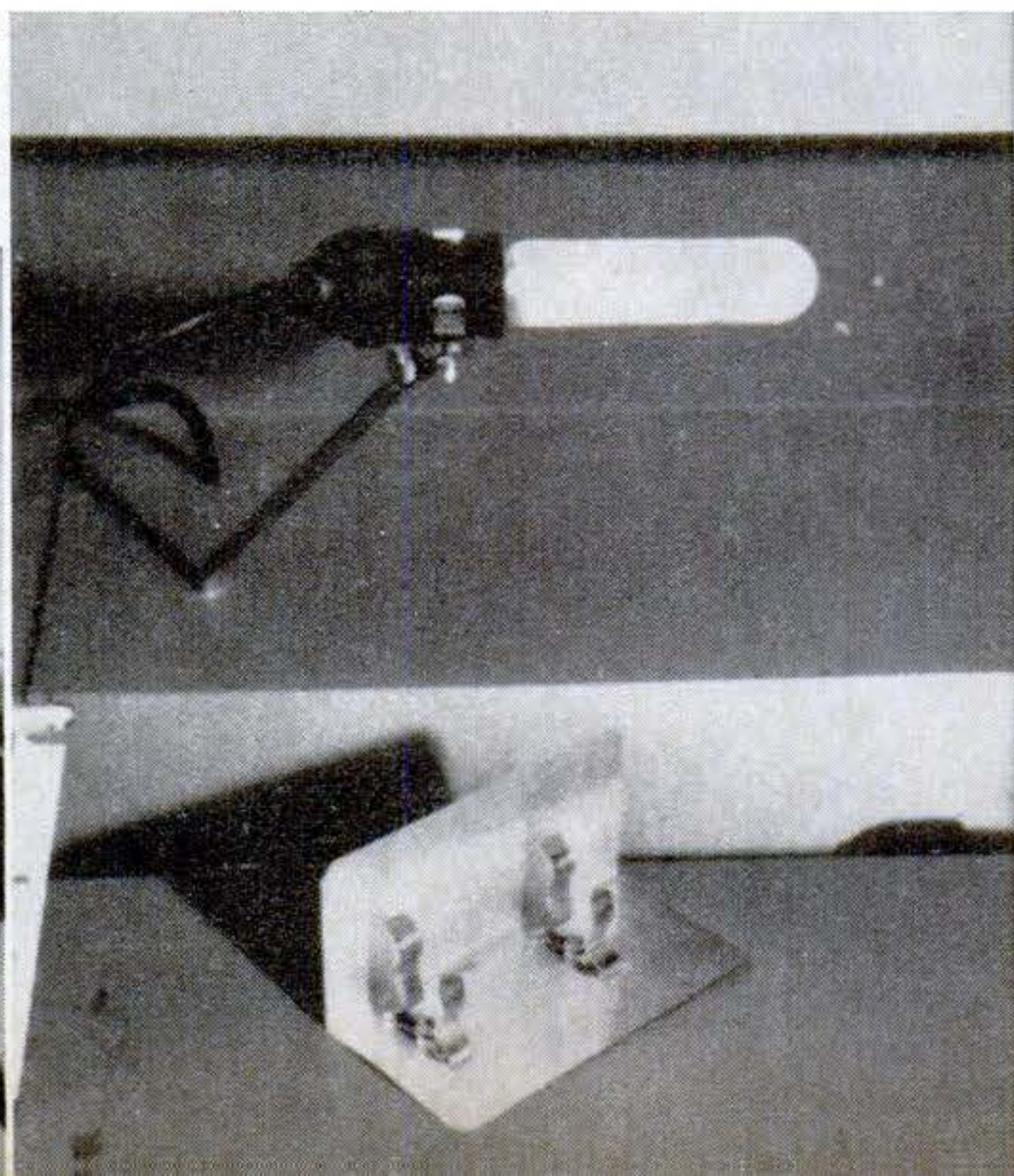
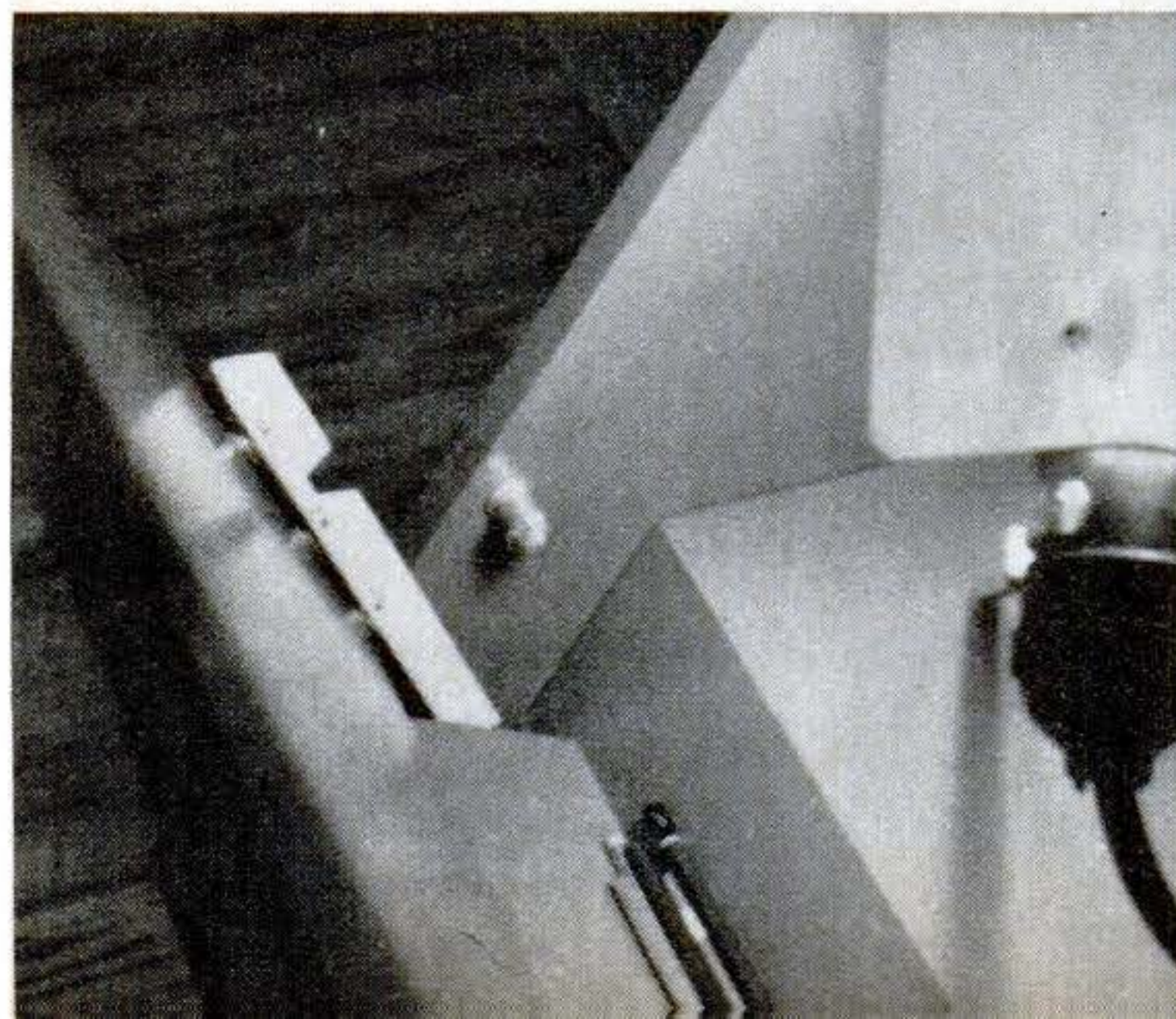
The body gets an enamel undercoat, then a rolled color finish of semigloss enamel. The feet can be given a natural finish—clear sealer and wax. The angle brackets and leg tubes (unless chrome plated) can be sprayed with metal primer and a contrasting color.

The light bulb shown is a 40-watt showcase type. The broom clips are Pop-riveted to the shade.

PS

The homemade hardware is ingeniously simple

Leaf-support bracket is steel angle attached with three bolts and shimmed up with washers so leaf is level when bracket is against stop as shown in photo at right; note that bracket pivots down into slot at end of trough. At right, shade is unclipped from bulb for demonstration.





This easy-to-build gadget helps you explore the mysteries of color—and makes you a color expert around the house

By RONALD M. BENREY
PHOTOS BY ORLANDO GUERRA

A COLORIMETER You Can Build

Here's the next best thing to a panel of color experts when it comes to judging — or matching — colors. It's a colorimeter — an easy-to-build electronic gadget that literally measures the color characteristics of any object or surface. You'll use it to match the color of paint to a previously painted surface; to gauge the effects of color change caused by painting two dissimilar surfaces with one color paint; and, to study the fascinating science of color.

Have you ever stopped to think why grass is green and barns are red? Or, why, in fact, any object you look at has a characteristic color?

The answer may surprise you: Color is really a *psychophysiological* phenomenon. This mouthful means that our minds play a vital part in the sensation of color. That's one reason why we are all suckers for the color "optical illusions" we'll be talking about later.

The familiar wave theory of light that's taught in high-school physics isn't a totally valid explanation of the subject,

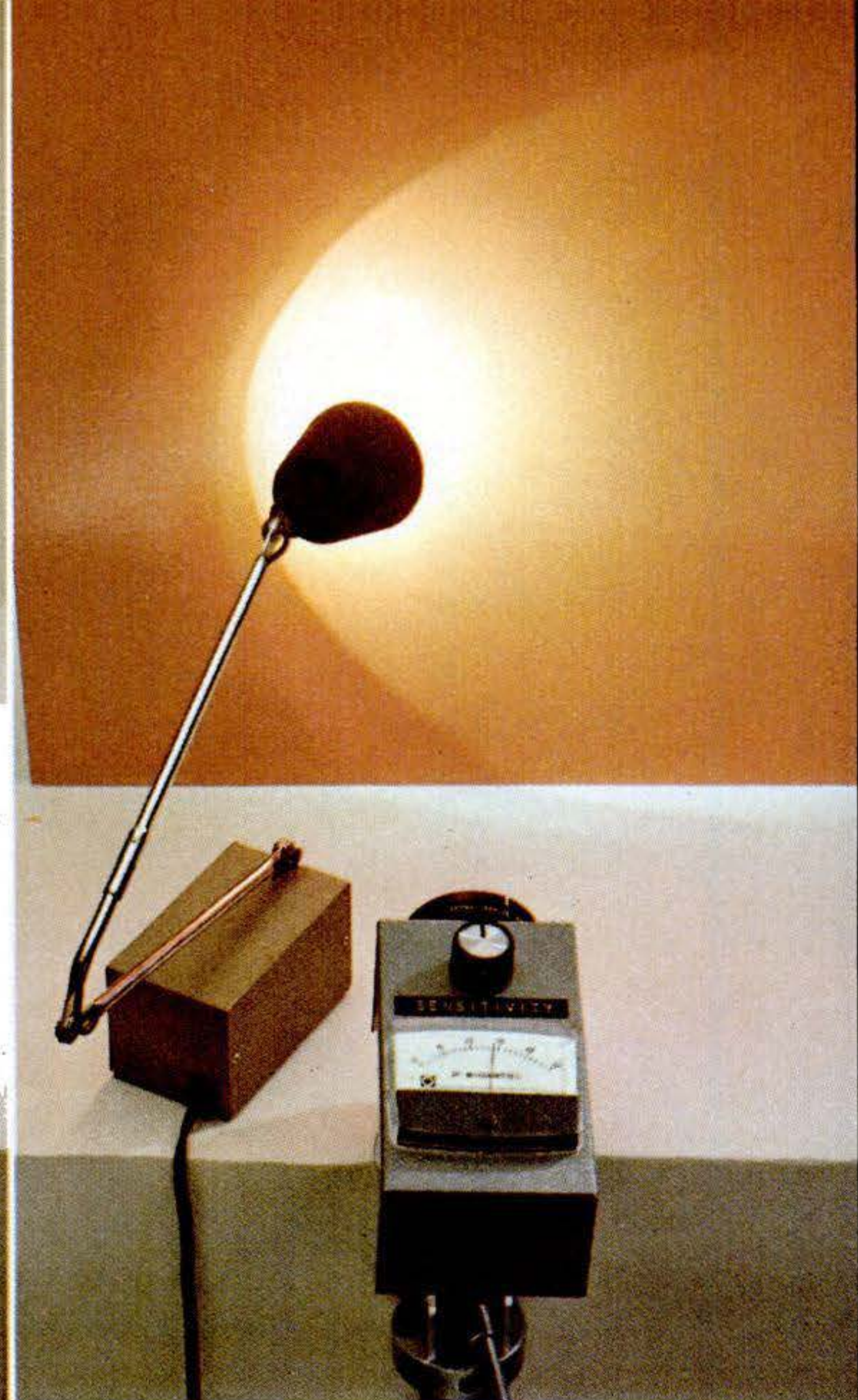
but it's a good start for any discussion of color. To put it simply, light is a band of electromagnetic waves that have the ability to excite a group of sensitive receptor cells in our eyes. These cells are linked to our brains via a complex nerve network.

We "see" because of a complicated interaction (not yet understood) between eye and nerves and brain, whenever light waves strike our eyes.

Further, some of the light-sensitive cells in our eyes have the ability to distinguish among light waves of different frequency. The net result is that our mind assigns a

Continued

LIGHT MAKES COLOR		
If object looks:	It is reflecting:	But absorbing:
Red	Red	Blue, green
Yellow	Red, green	Blue
Green	Green	Red, blue
Cyan	Green, blue	Red
Blue	Blue	Red, green
Magenta	Blue, red	Green



Practical experiments you can perform with your colorimeter

Choose a strong, high-wattage light source for all tests. A high-intensity lamp like the one shown above gives the whitest light. Set up a target of white dull-finish cardboard. Adjust sensitivity before each reading; once the meter is mounted before the target (tripod is best) remove all filters, as in first photo, and dial maximum on-scale reading — in most cases, well under the top-of-scale 50. Now insert each filter in turn. Readings shouldn't vary.

For comparison, duplicate the test with other light sources that appear white: incandescent and fluorescent bulbs, or daylight on a cloudy

day. This will demonstrate how the color corrective ability of your eye/nerves/brain system adapts itself to see such lights as white even though they are not. (By definition, white light has equal distribution of light frequencies.)

Wide variations in actual color of "white" light sources explain why colored objects look different under various types of light. Before choosing a color for use in your home, use your colorimeter to check that the ambient light in the store is similar to light at home.

The other three photos above show how to match an existing color. First, take successive

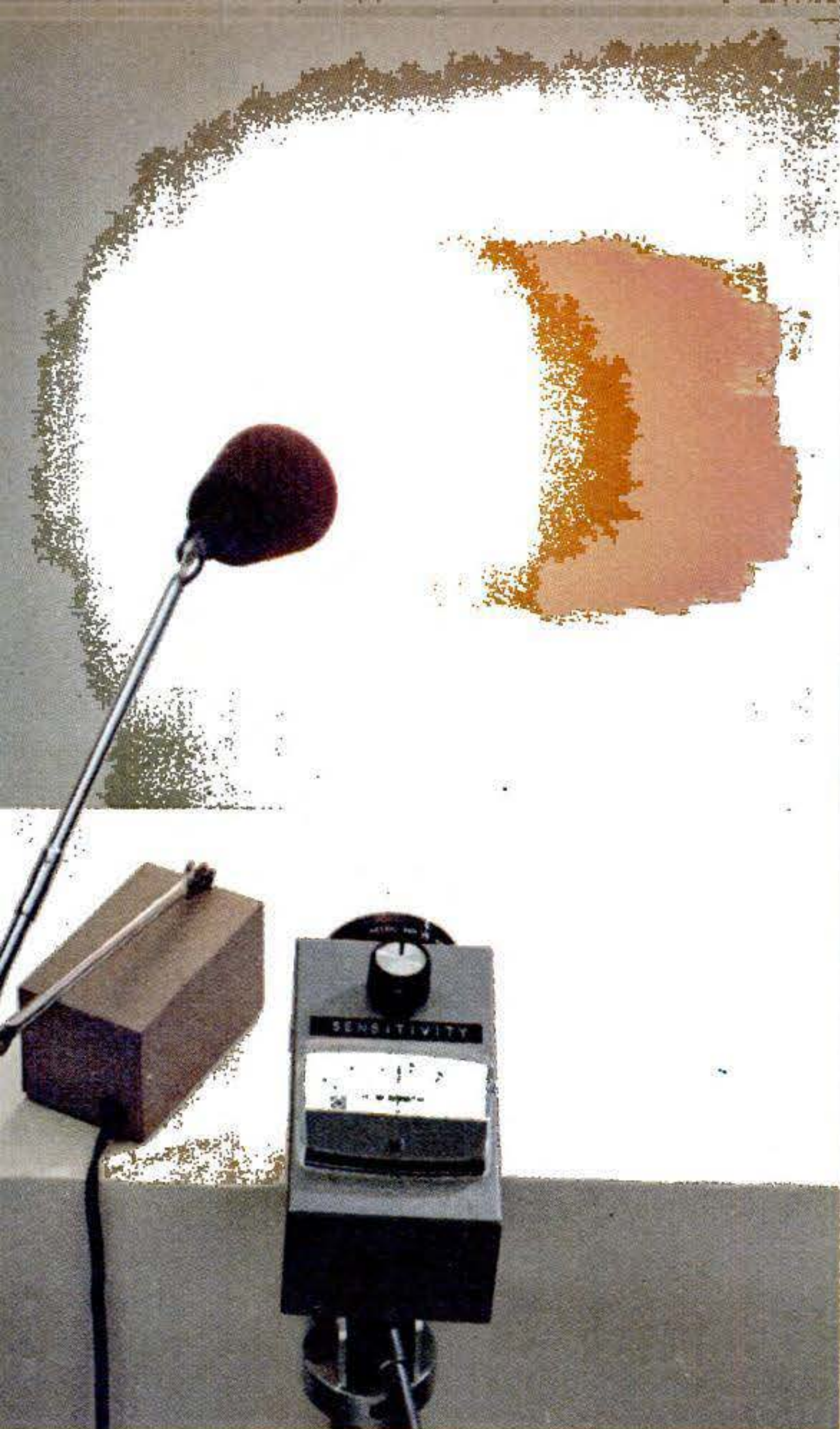
different color to the different frequencies.

Just keep in mind that a red object looks red because our eye/nerves/brain seeing system interprets the light waves bouncing off the object as predominately red light waves—and so on for the other colors in the spectrum.

People are color-blind when their eye/nerves/brain seeing system lacks the

ability (partially or completely) to distinguish between the different wavelengths of light.

The most popular theory explaining color vision states that our eyes do not tune across the spectrum of light waves and pick out specific frequencies. Instead, one group of cells is particularly sensitive to reddish-colored light waves; another to



readings of a large color sample with three filters. Then take duplicate readings of a test smear of new paint, taking care not to move either light or meter. Photo directly above shows lower reading than original sample, using same filter. You correct this by adding pigment specified in the chart, next page, until test-smear reading matches (right).

Similar tests let you modify color of paint you are using so that it looks the same when applied to two different types of surfaces.

Remember, in matching paint, you are dealing with a subtractive color process: Every bit of pigment you add to a paint color prevents final film surface from reflecting particu-

lar colors. In effect, the surface subtracts those colors from white light striking it.

Add only a small quantity of pigment at a time. With a subtractive process, you can't regain the loss of reflected color. Pigments may have other names than magenta or cyan.

Some tips on making your comparison tests:

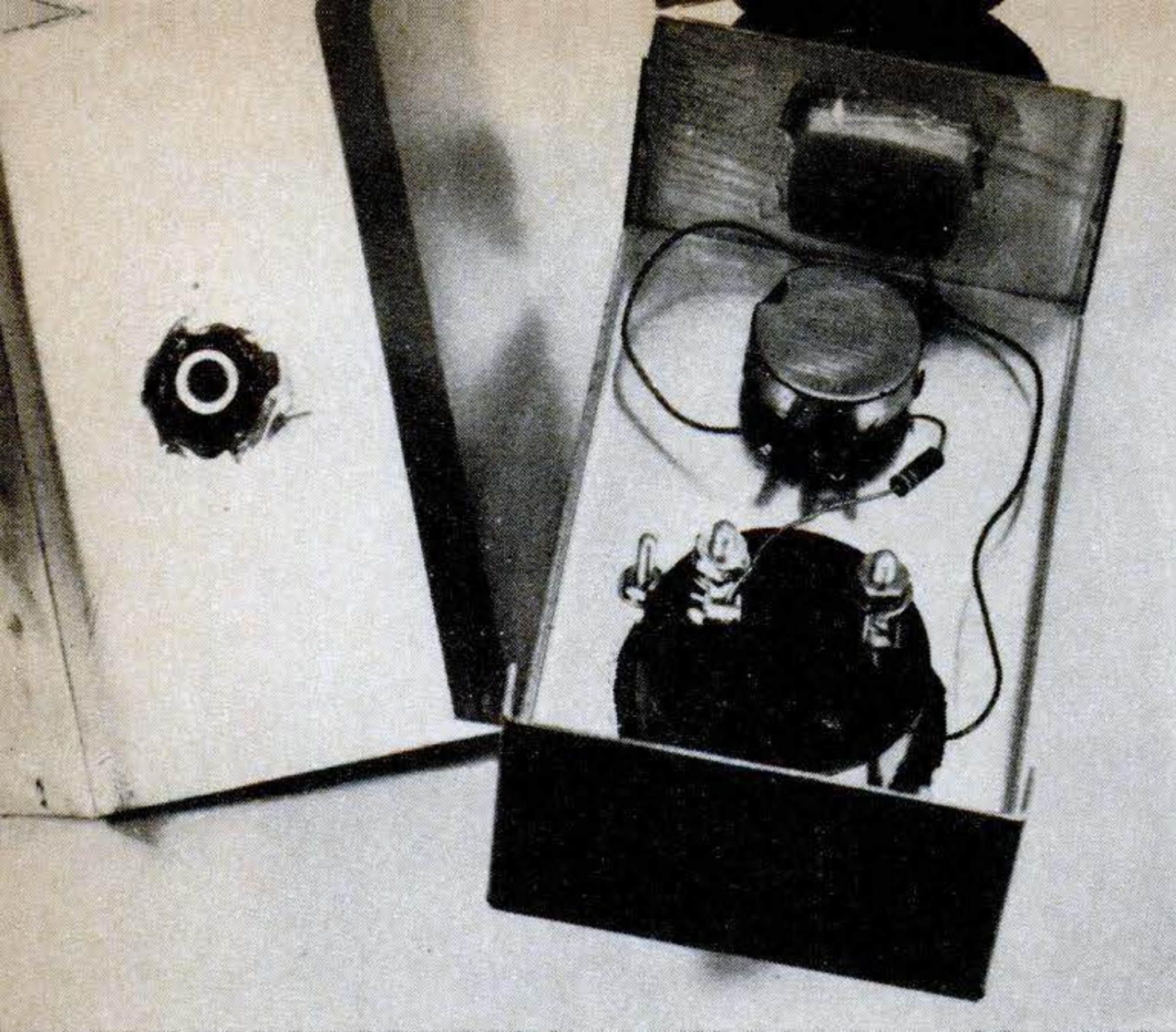
- Compare only dried paint samples. Wet surfaces introduce color-changing effects.
- Keep distance constant between samples and light source and samples and meter.
- Ideally, samples should be same size, and viewed against dark background. Samples should be large enough so meter's cell doesn't "see" any extraneous background.

greenish waves; and a third to bluish waves. The sensitivities of the three groups of cells overlap so that our seeing system has the capability of recognizing colors in between red and green, and between green and blue.

The classic experiment to demonstrate this theory uses three primary-color light beams — one red, one blue, and one green

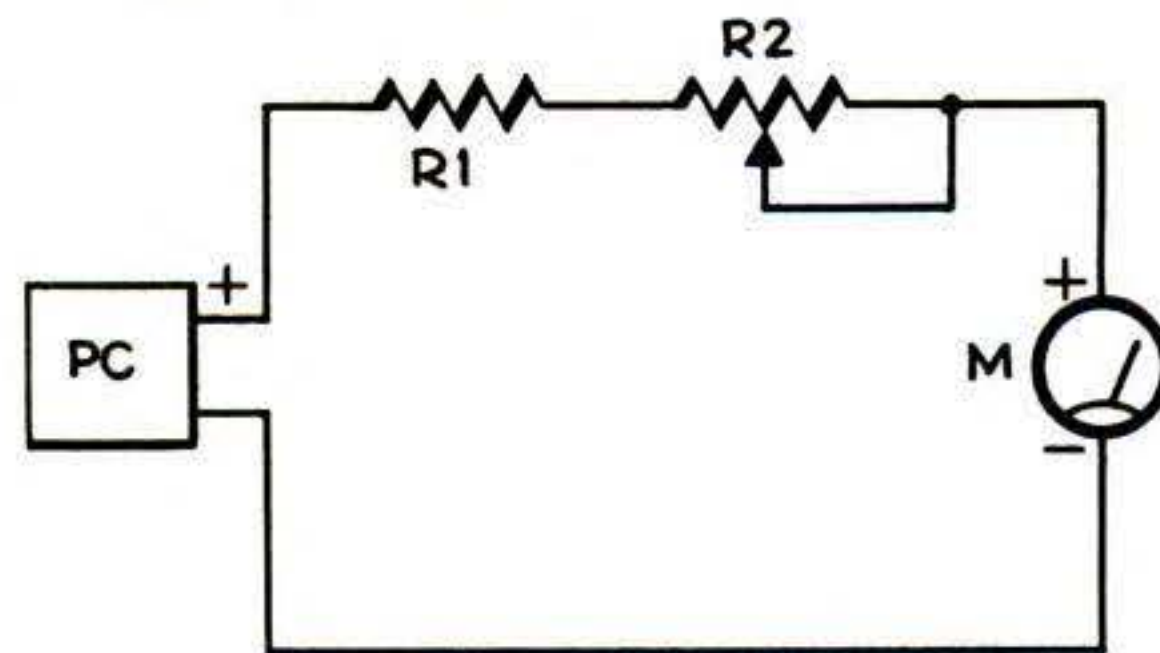
— to create a wide range of colors. (Red, blue, and yellow are the *pigment* primaries, which don't concern us here.) You can duplicate this light experiment with your colorimeter's three color filters, if you have three directed beams of white light — such as three slide projectors, or three high-intensity lamps. See the photo at the left, above.

Continued



PARTS LIST

- R1—2,200-ohm 1/2-watt carbon resistor
- R2—5,000-ohm linear taper carbon potentiometer
- PC—Internat'l Rectifier B3M selenium photocell
- M—0-50 microampere DC microammeter
- Misc: Aluminum minibox; Series VI or VII filter holder; three filters: #25A (red), #47 (dark blue) and #58 (dark green)



Simple circuit consists of photovoltaic cell (PC) connected to adjustable voltmeter (resistors R1 and R2 in series with panel meter, M). PC acts like light-powered electric generator. Light that strikes it is transformed into voltage.

This phenomenon means, for example, that our seeing system “adds” a red light and green light and comes up with a yellow color sensation that is identical to the color sensation produced by a true yellow-colored light. A red light superimposed on a blue light creates the visual sensation of magenta—and so on. This concept is actually the basis of our color-television system.

The color of objects. We perceive that objects have color essentially because their surfaces have the ability to absorb some frequencies of light waves and reflect others.

Suppose we have a perfectly white beam of light containing all frequencies of light waves of the same intensity. If we shine the beam at a red rose, the flower’s surface

reflects red, and absorbs the blue and green frequencies. The table (first page) shows how components of white light can be “subtracted” by colored surfaces, leaving a reflected component that gives the object its apparent color.

The actual color we perceive depends on three main factors:

- The object’s ability to absorb certain frequencies of light.
- The actual color of the light beam illuminating the object (blue objects won’t look blue under a yellow light, since the beam doesn’t contain any blue light for the object to reflect).
- The color corrections made by our eye/nerves/brain seeing system—in other words, how this system “sees” the color.

[\[Continued on page 194\]](#)

HOW TO CORRECT COLORS WHEN READINGS DON'T MATCH

FAMILY OF COLOR BEING MIXED	RED READING OF TEST SMEAR		GREEN READING OF TEST SMEAR		BLUE READING OF TEST SMEAR	
	If higher than sample	If lower than sample	If higher than sample	If lower than sample	If higher than sample	If lower than sample
Red		add red	add magenta		add yellow	
Blue	add cyan		add magenta			add blue
Green	add cyan			add green	add yellow	
Magenta	add blue	add magenta			add red	add magenta
Yellow	add green	add yellow	add red	add yellow		
Cyan			add blue	add cyan	add green	add cyan



We hate to dampen the spirits of other trucks. But scrappage records show Chevy pickups outlast others.

What makes us so tough? For one thing, we use two pieces of sheet metal in our cab. Double-wall it, for strength.

And we build our independent front suspension to expect the worst from a road. Without getting rattled.

Another thing. We just won't leave well enough alone. For instance, you can now order a powerful new additive for regular gas: a 400-cubic-inch V8.

It's not that we're out to make it tough for other trucks. We're out to make it easier for you.

Because putting you first, keeps us first.

CHEVROLET
On The Move.

**You'll still be washing it
when other '70's are washed up.**

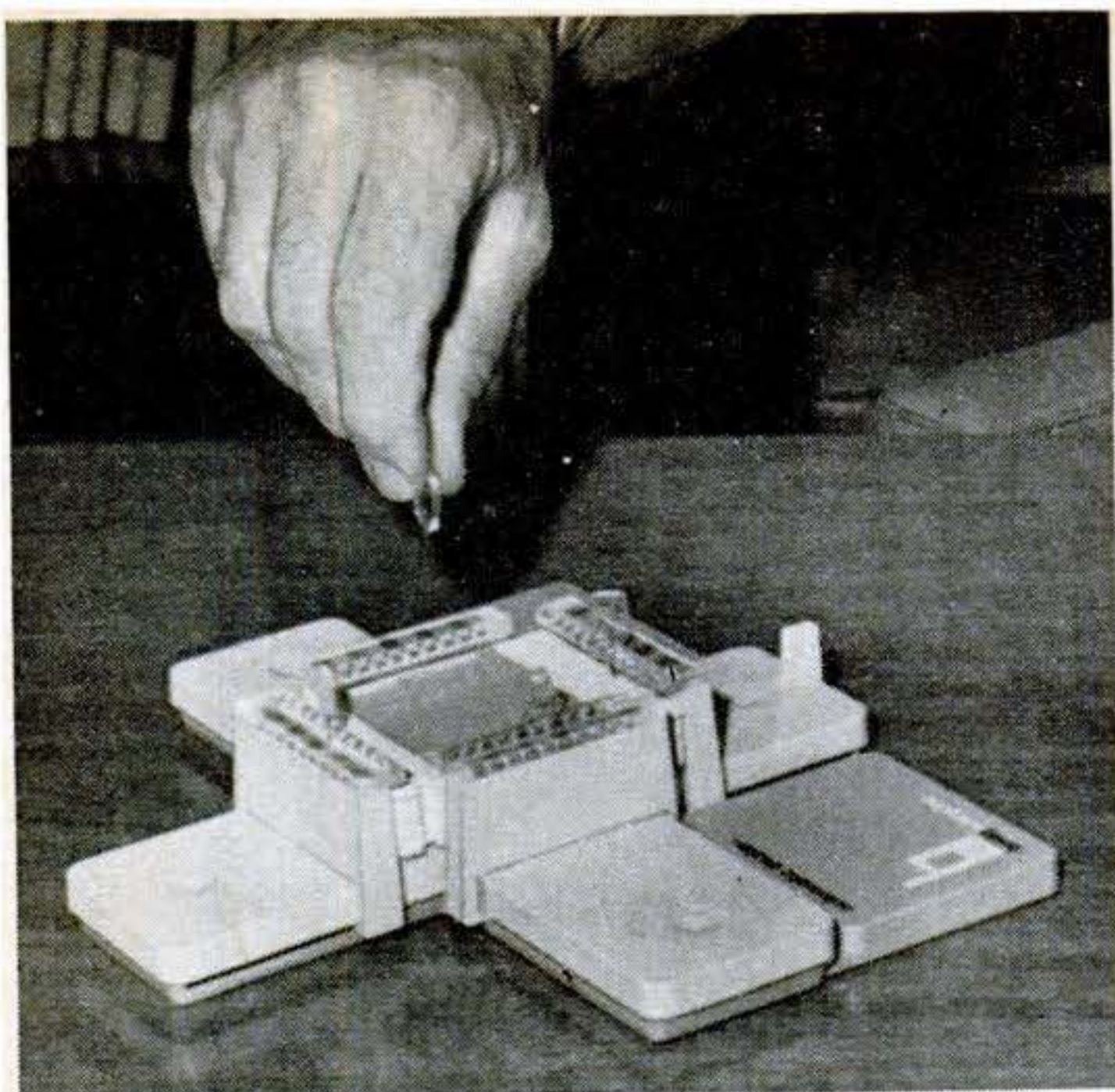
**Will a 6-pak
convert you to
Budweiser forever?**



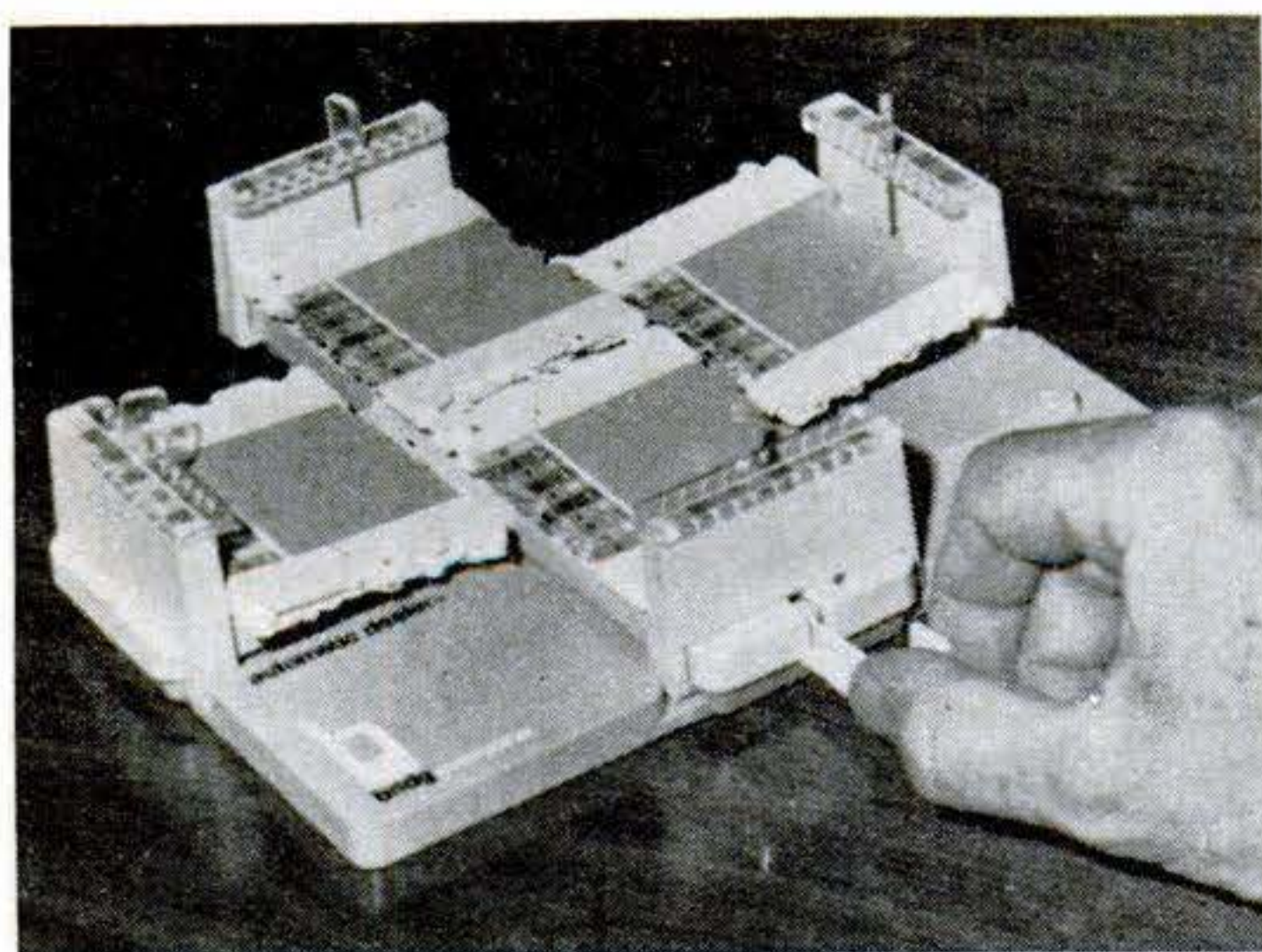


**(Well, one good thing
leads to another.)**

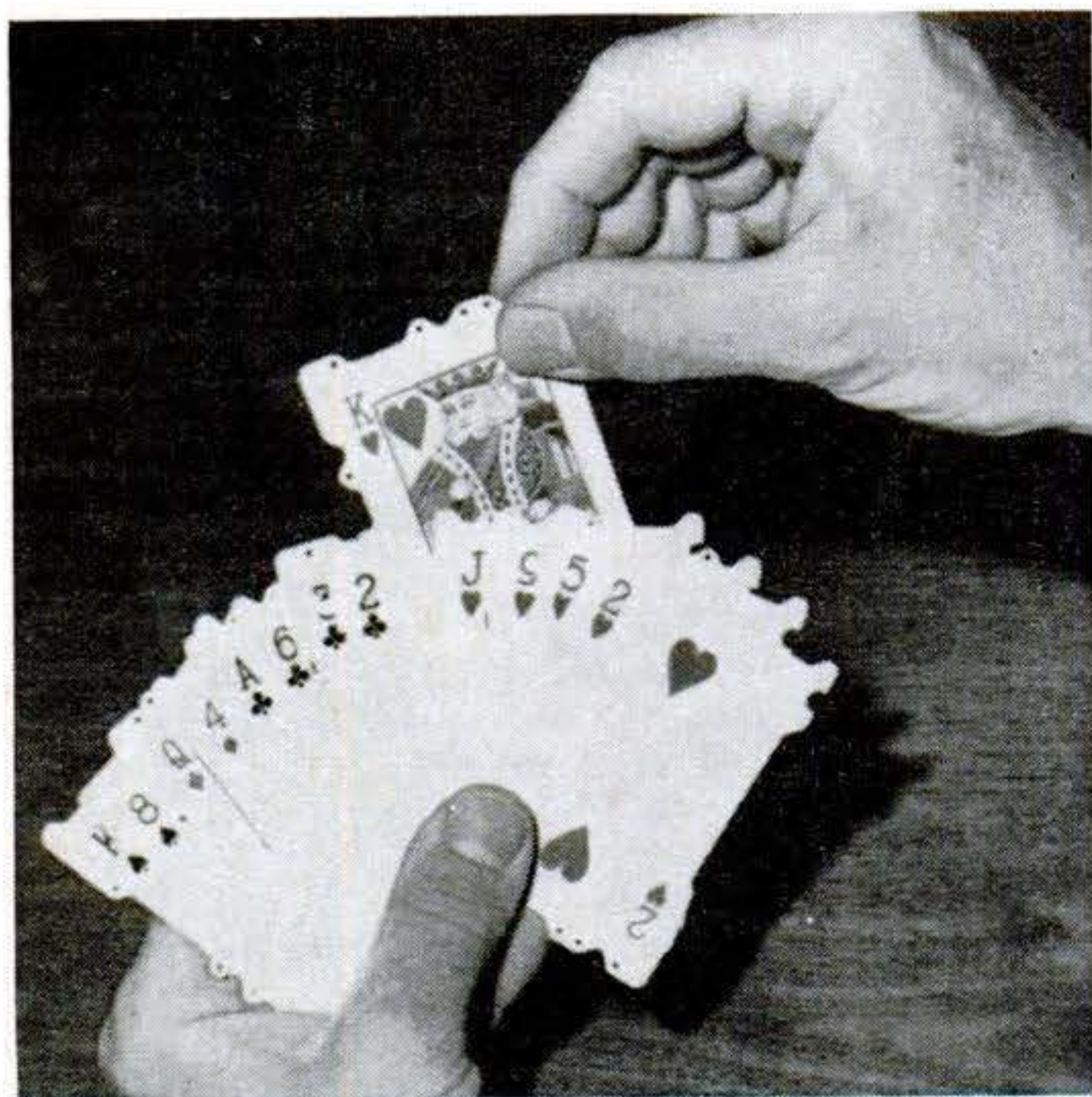




Pins inserted into color-coded holes in the four sides of the "automatic dealer" select the hands.



Pulling a handle in the base makes the sides slide outward, pulling pre-programmed cards with them.



Playing is guided by color markings and numbers on the card backs and by Charles Goren's instructions.

The Little Computer That Teaches You Bridge

By PAUL WAHL

How would you like to take bridge lessons from a world-famous expert right in your own home? I did, and you can—with Charles Goren. He won't be sitting right at the table with you, but he selected the 40 hands you'll play and he wrote the instructions that will tell you when you make a mistake, and why.

Learning is easy and fun, because of a system called Bridgeeveryone. The heart of it is a gadget that simplifies and speeds up sorting a deck of cards into many pre-programmed hands for your 18 lessons.

Here's how it works. You drop one of the two special decks into the center holder of the "automatic dealer." Then you insert a plastic-headed pin into one of the holes on each of the holder's four sides. Holes are color-coded and numbered for identification. The playing cards have holes and notches that line up with the holes in the deck holder. So inserting the pins hooks some cards and ignores others.

Pulling a handle in the gadget's base makes the four sides slide outward, pulling the pin-selected cards with them. You can play one hand by yourself while Charles Goren "plays" the others, or you can invite friends to play the hands.

Color markings on the backs of the cards tell which hand you're playing. Numbers indicate the order in which Goren says the cards should be played. In a booklet that comes with Bridgeeveryone the expert tells why. In another booklet he explains the complete rules of the game. Robert H. Hallowell Industries, 717 Fifth Ave., New York City 10012 sells the outfit for \$29.95.

I'm still no tournament player among the world's 100 million bridge enthusiasts. But no one laughs when I sit down to play.

Plymouth



1970 Hemi-'Cuda with "Shaker" hood.

Our 1970 Barracudas are totally new. From the plush Barracuda Gran Coupe to the tough little 'Cuda with the Hemi engine.

The Hemi-'Cuda. With a Quivering Cold

Air Grabber poking through the hood. So the 426 cubes below can breathe easy.

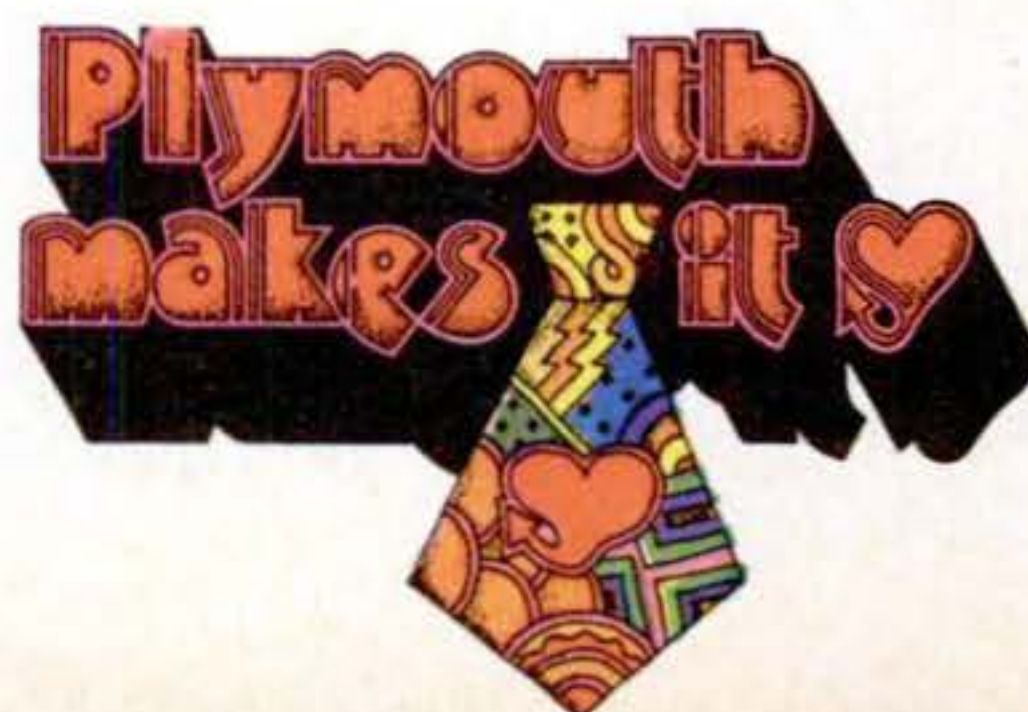
Very possibly this is the fastest production car in the country.

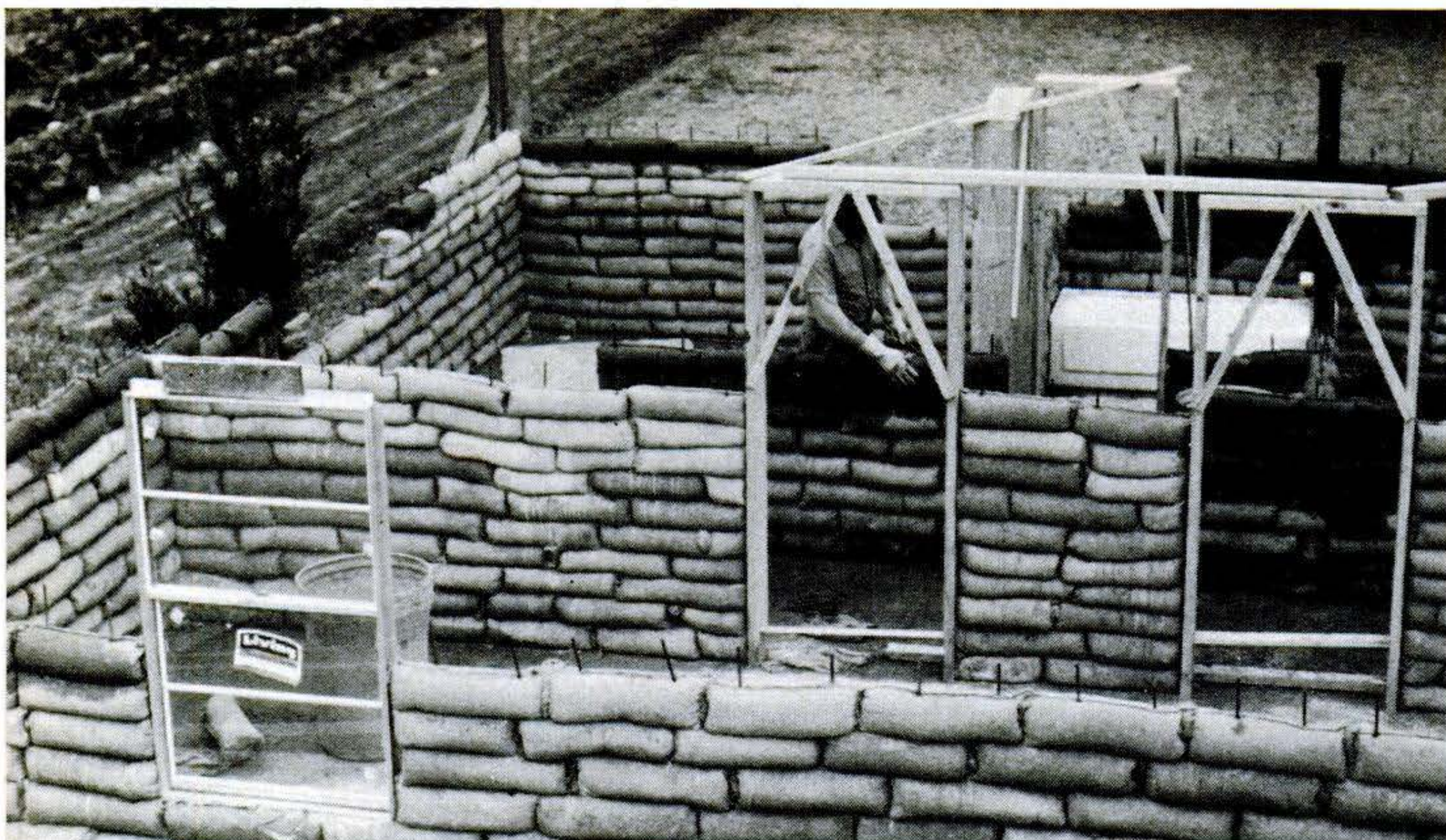
If you had something

gentler, but equally sporty, in mind, we also make Barracuda and the Barracuda Gran Coupe.

So remember the name, new people. Barracuda. It's all yours.

Hello, new people. We have a new car for you.





Bags of concrete, piled up between door and window frames, form the Stack-Sack home's structural walls.

STACK-SACK HOUSES... Build 'Em by the Bag



Filled with dry concrete mix, burlap bags are dipped in water just before stacking, then rod-pinned.

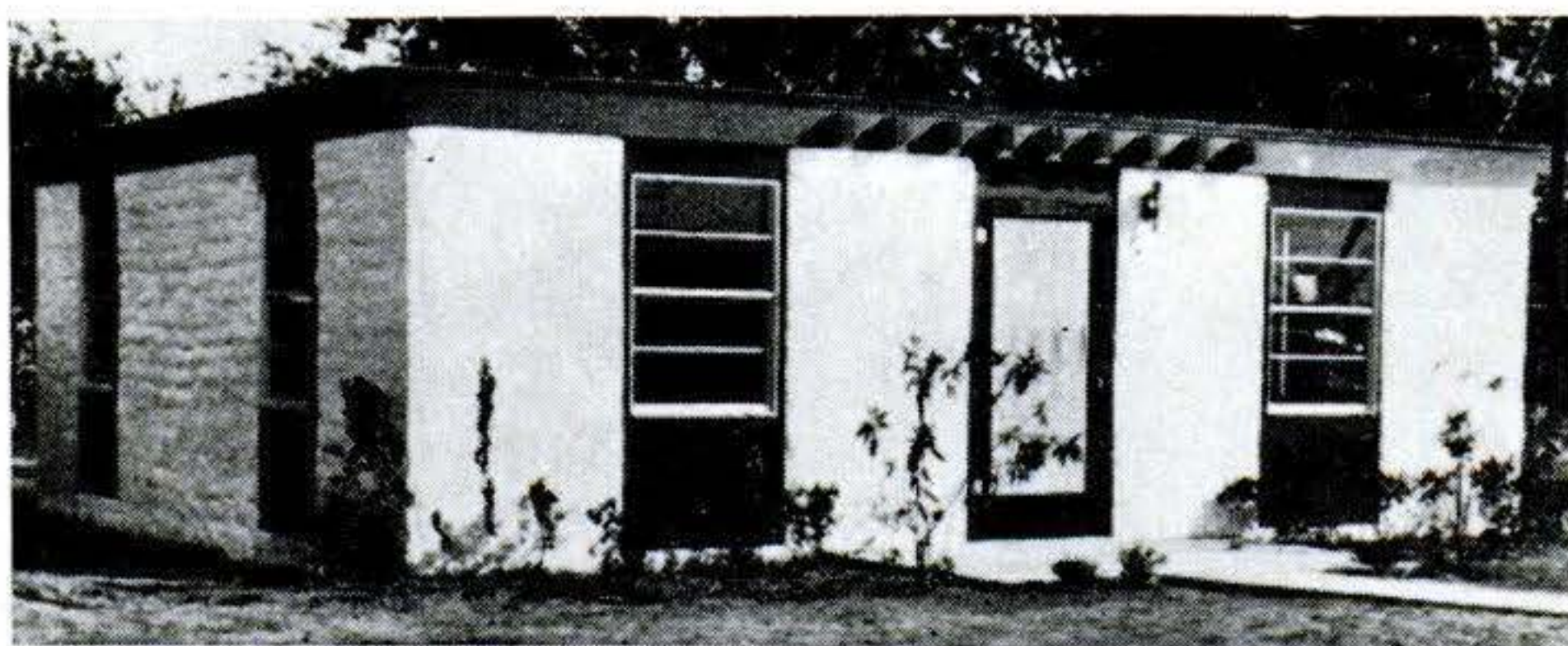
Spanish style with flat roof is popular in the Southwest, but Stack-Sack method works with any house.

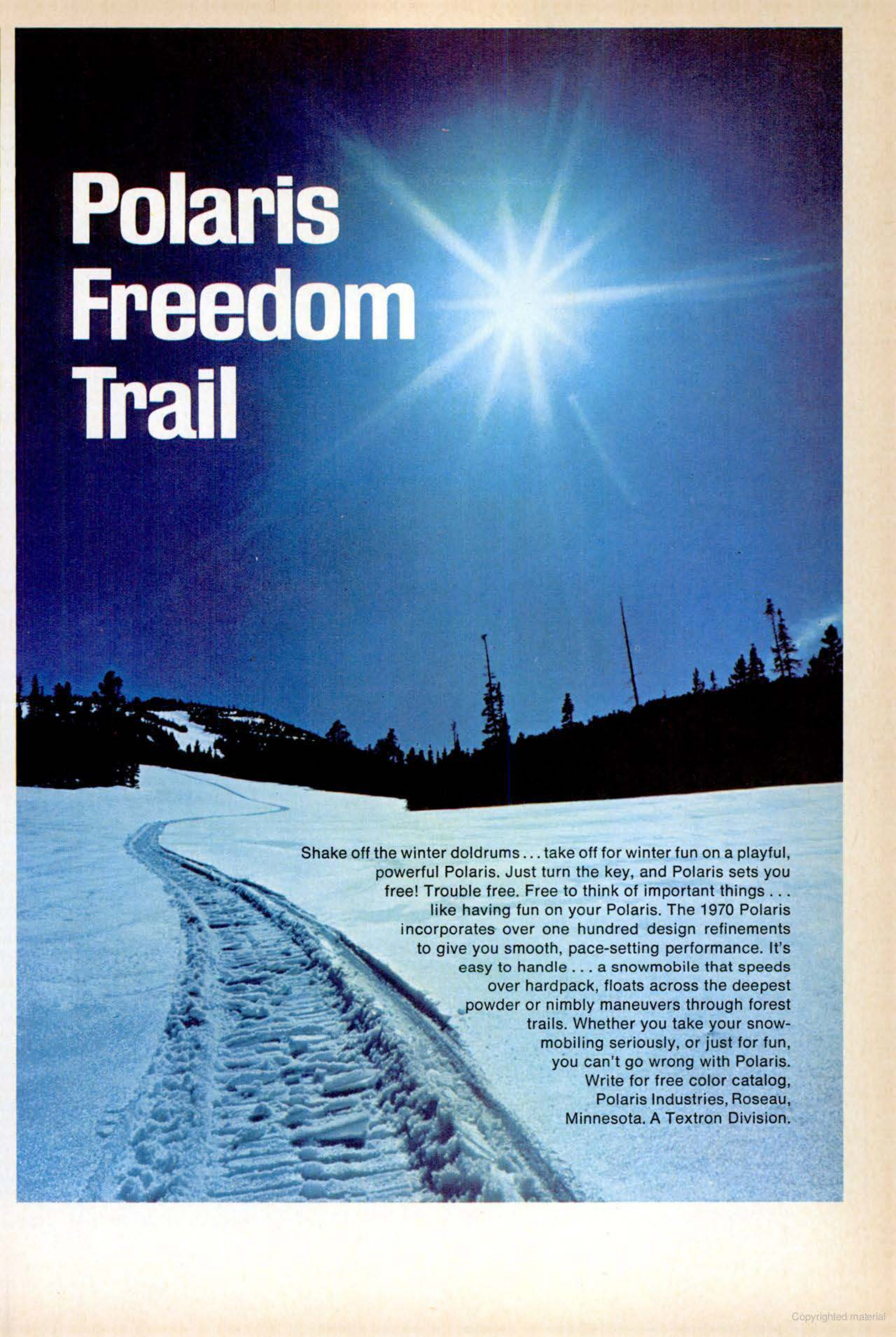
Using sacks of concrete as some Indians use adobe, a Texas builder is putting up two-bedroom houses—with all major appliances—that sell for only \$4,975. Edward T. Dicker, inventor of Stack-Sack houses, decided that constructing forms for poured concrete structures only to tear them down later is wasteful.

Dicker's method is much simpler. He pours concrete footings for the bearing walls, sets up floor-to-ceiling door and window panels, roughs in plumbing and electrical conduit, and fills the open wall spaces with piled-up sacks of concrete.

Three ingenious techniques make Stack-Sack work. First, the cylindrical 6-in.-by-24-in. burlap sacks are machine-filled with a dry cement-sand mix. They're immersed in water just before being stacked and the concrete inside hardens in place. Then each sack is pinned to the one above and below with two 10-in. steel rods. Finally, the completed walls are sprayed inside and out with gunite to a minimum depth of 1/2 in.

Six unskilled workers can build a two-bedroom house in 14 days. Dicker Stack-Sack International, 2600 Fairmount, Dallas, Tex. 75201, is licensing its method world-wide for use by local builders.



A full-page photograph of a snowmobile trail. The trail, marked by deep tracks, winds from the bottom left towards the center of the frame. The surrounding landscape is covered in snow, with dark evergreen trees silhouetted against a bright blue sky. A large, brilliant sun is positioned in the upper right, creating a starburst effect and casting a soft glow over the scene.

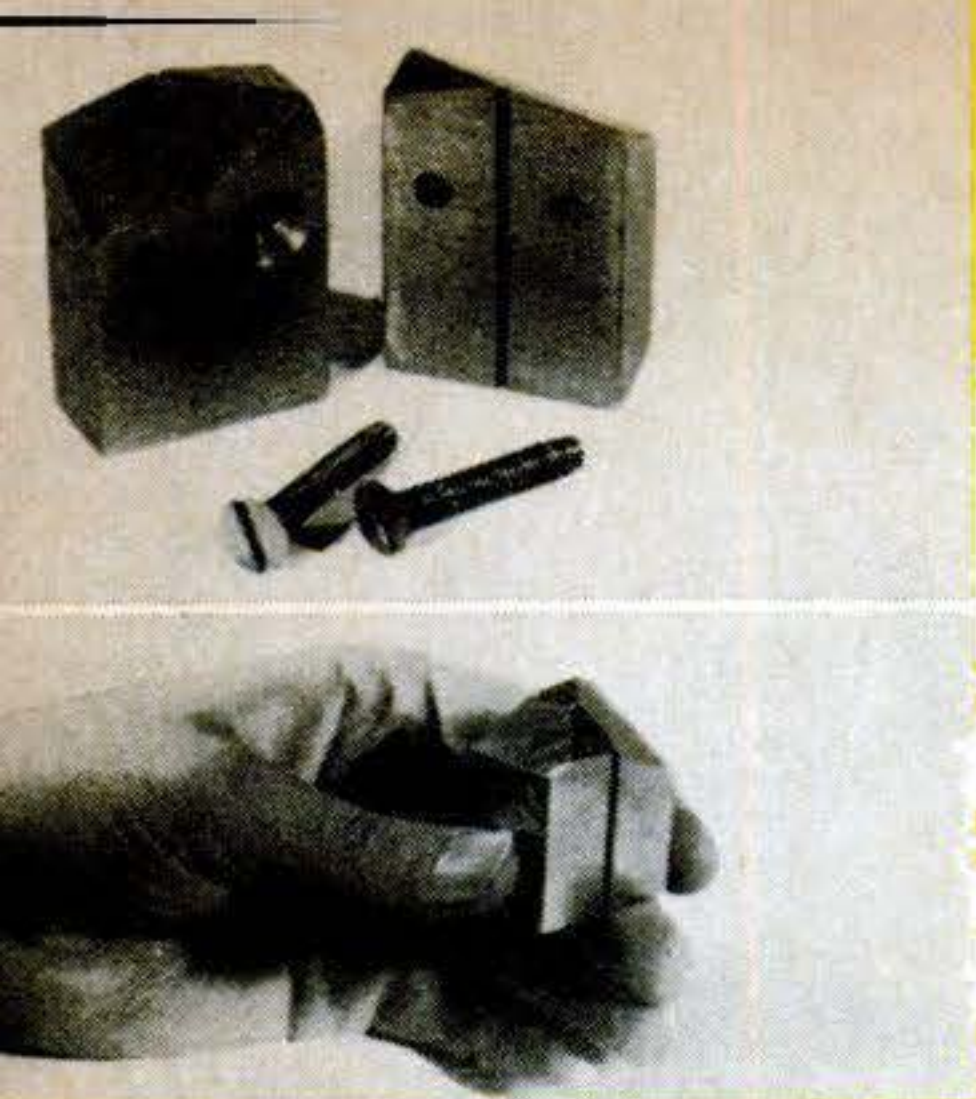
Polaris Freedom Trail

Shake off the winter doldrums . . . take off for winter fun on a playful, powerful Polaris. Just turn the key, and Polaris sets you free! Trouble free. Free to think of important things . . .

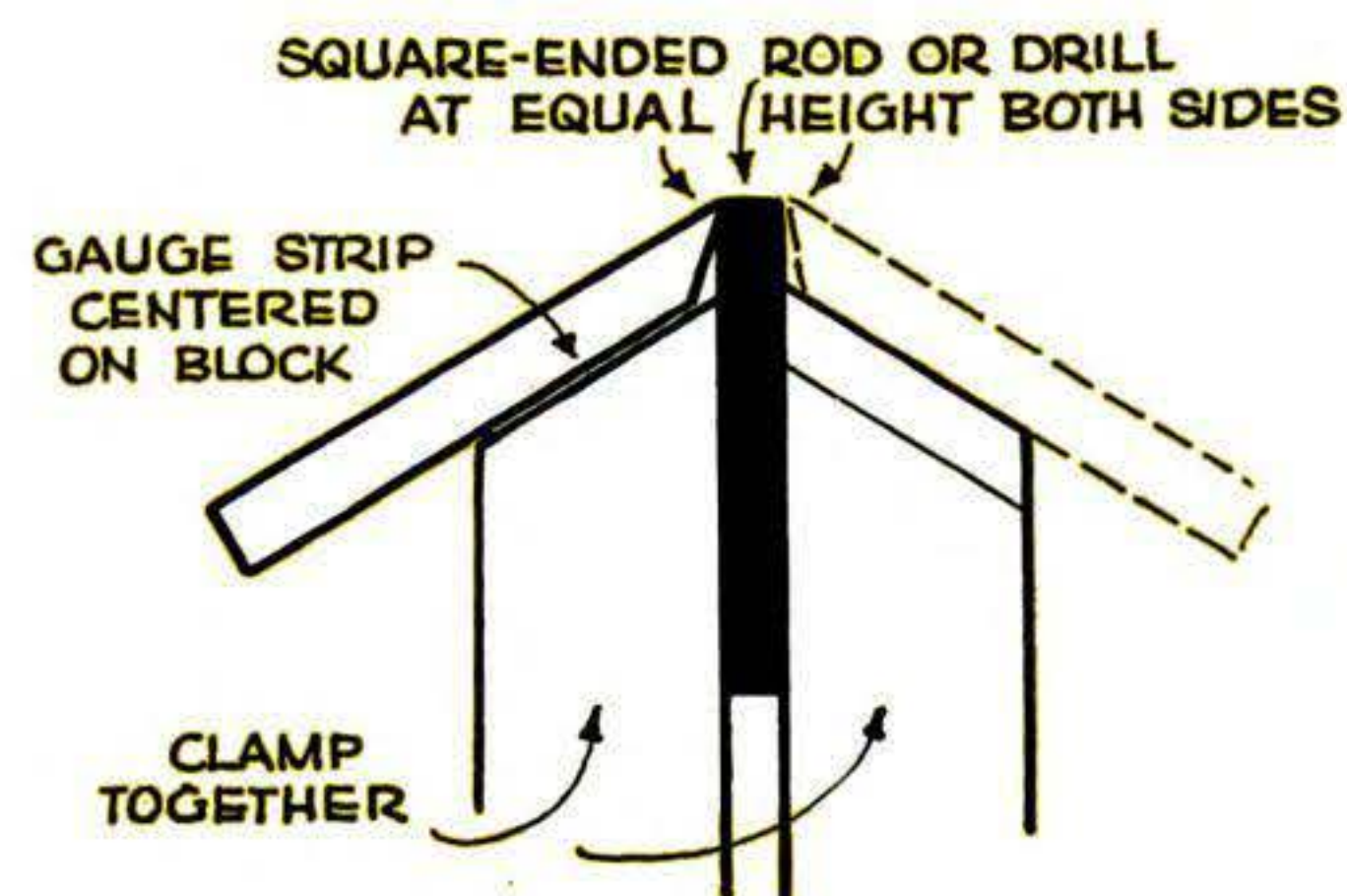
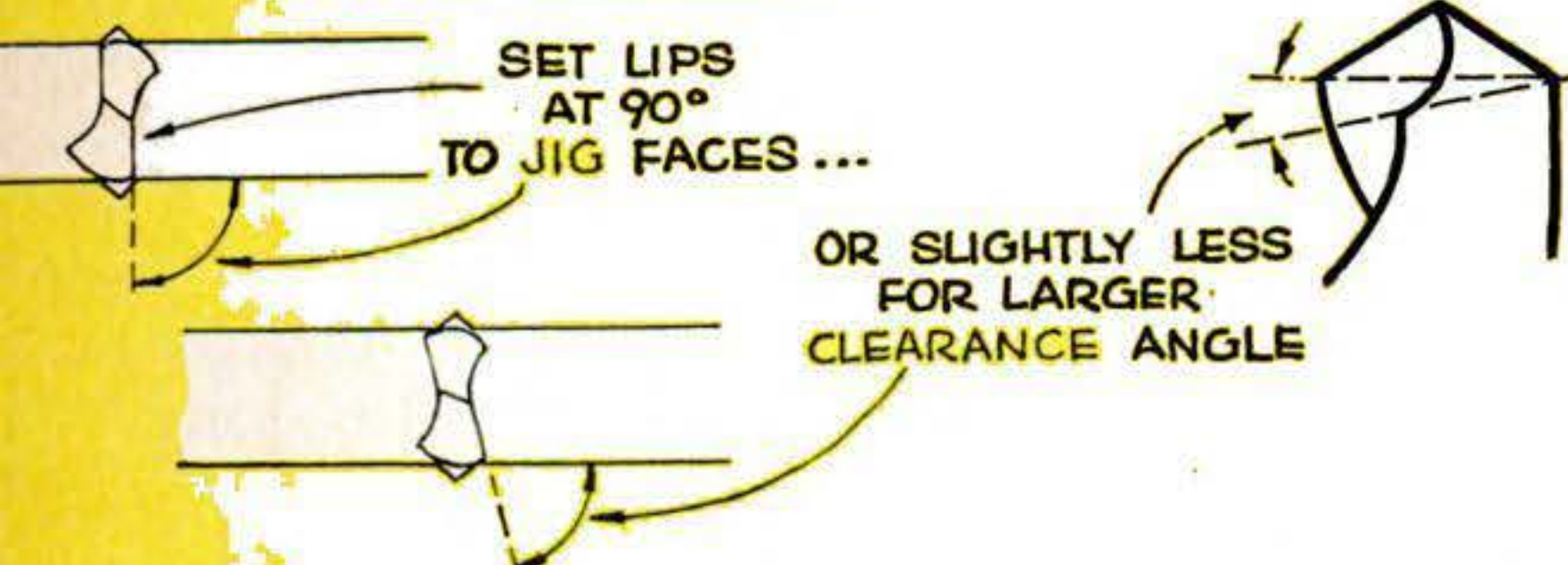
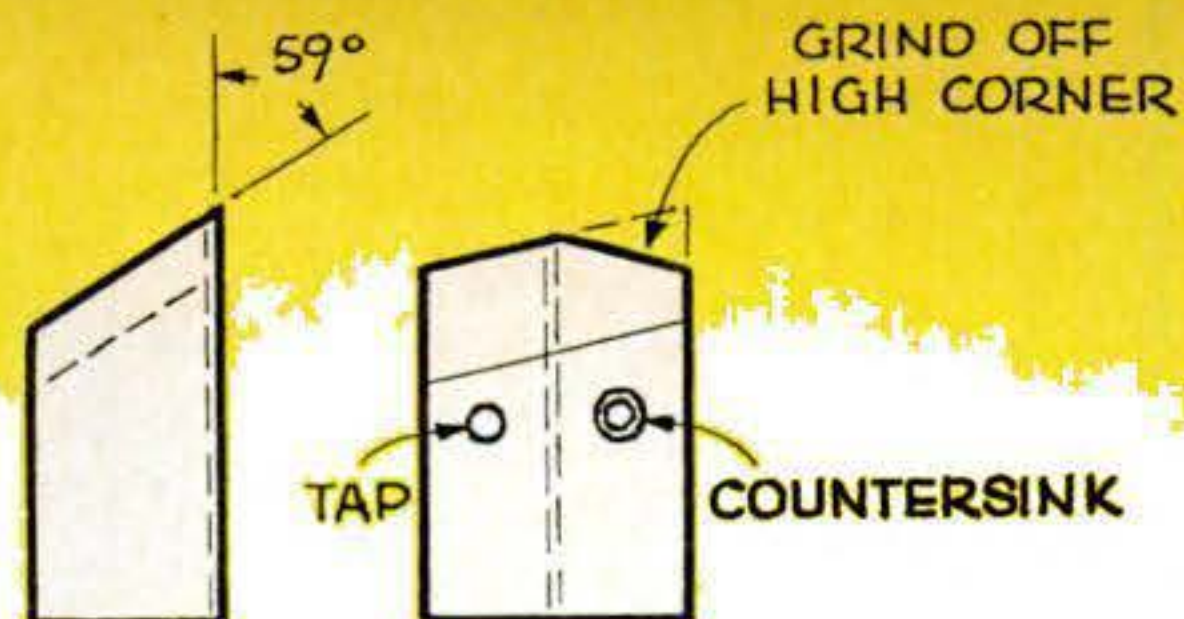
like having fun on your Polaris. The 1970 Polaris incorporates over one hundred design refinements to give you smooth, pace-setting performance. It's easy to handle . . . a snowmobile that speeds over hardpack, floats across the deepest powder or nimbly maneuvers through forest

trails. Whether you take your snowmobiling seriously, or just for fun, you can't go wrong with Polaris.

Write for free color catalog,
Polaris Industries, Roseau,
Minnesota. A Textron Division.



STEEL BLOCKS (2 REQ.)
1/2" x 3/4" x 1 1/8"



Clamp any small drill, right down to No. 60, in a jig like this and you can sharpen it with a small handstone. The jig insures cutting lips of equal

length and equal angles. Sloping surfaces guide stone. Drill-point surfaces will be flat instead of conical, but this is okay on small drills.

How to Sharpen Tiny Drills

By FRED H. TRACY

To make the jig above, cut two blocks of cold-rolled steel, 1/2" thick, 3/4" to 1" wide, and a bit longer than your smallest drill. In one wide face of each block, make a shallow groove with a triangular file. Center the grooves parallel to the edges. Make them the same depth in both blocks. For drills to No. 60, they should be little more than 1/64" deep.

Form the oblique surfaces accurately on a grinding wheel or power sander. Tilt the rest or table down 12 degrees, clamp a block to the rest or set the sander miter gauge at 59 degrees to the abrasive surface. Grind the resulting compound angle across both blocks. Then grind off the high corner as far as the groove.

Square off the shank end of a 3/32" drill or rod by grinding. Clamp it between the blocks, the squared end about 3/16" above them, adjusting to hold the grooved faces of the jig parallel.

Cut a sheet-metal strip as in the drawing. Hold it on each angled face in turn, at 90 degrees to the grooved ones, using a magnifying glass to check the height of the rod. Realign the blocks as necessary

so that the end of the rod is exactly the same height above both.

With the blocks so clamped, drill two No. 36 holes through both. Separate the blocks. Tap the hole near the lower corner of each sloping face 6-32. Open the other clearance size for a 6-32 bolt and countersink it.

To sharpen a drill, clamp it between the blocks with the cutting lips at 90 degrees to the grooved faces and the point surfaces slightly above the jig surfaces. A magnifying glass may be useful again here.

Hold the jig firmly on a table or bench edge. Stone the drill with a medium-fine pocket stone, or a square or triangular abrasive file. Apply pressure over the sloping jig faces, taking care not to rock the stone. Sharpen each point surface of the drill completely flush with the jig face; if one is left slightly high, the drill will make an oversize hole. When slid from right to left on the jig face, a sharp-edged stone or straightedge should not "catch" on the drill.

Remove the drill and check the clearance angle. If it is insufficient, the drill won't penetrate. Resharpen it with the lips turned counterclockwise to a bit less than 90 degrees.

GO with the best!



BEAUTIFUL

Distinctive styling and design refinements make the all-new Big "A" the one to go with. Nine beautiful models with sleek, graceful lines . . . flawless construction and finish. And Alouette is first with safety features. New emergency kit with spare plug, drive belt, pull cord, light bulb. New permanently mounted instrument dashboard eliminates short circuits. New caster and camber steering banks skis for safer turning. New one-piece steel underbody welded to steel chassis for maximum strength and safety. New safety-design seat and backrest for non-slip support. Good reasons to go Alouette.

1970
Alouette[®]
 The Reliable One

EXCITING

The powerful Big "A" is a top performer in every way . . . and you can trust the rugged, sure-footed Alouette anywhere. Low center of gravity and wider track skis give better traction and stability. Alouette's new variable speed, cam-operated torque converter transmission is electronically dynamically balanced for safe, smoothly controlled power. From the lively 277 c.c. to the luxury widetrack

Big Bird and new high-performance competition models, Alouette is way out front. So if it's exciting action you want, go with the best. Go see your Alouette dealer.

FEATHERWEIGHT CORPORATION, MONTREAL, CANADA



Taking Care of Your Car

Under-hood insulation

To keep sound-deadening pads under your hood from collecting dirt or becoming water soaked, cover the pads with heavy aluminum foil. Secure foil to pad with adhesive. If pads themselves are sagging, you can run lightweight coil springs across insulated areas, mounted in small holes you can drill in raised edges around the pads.

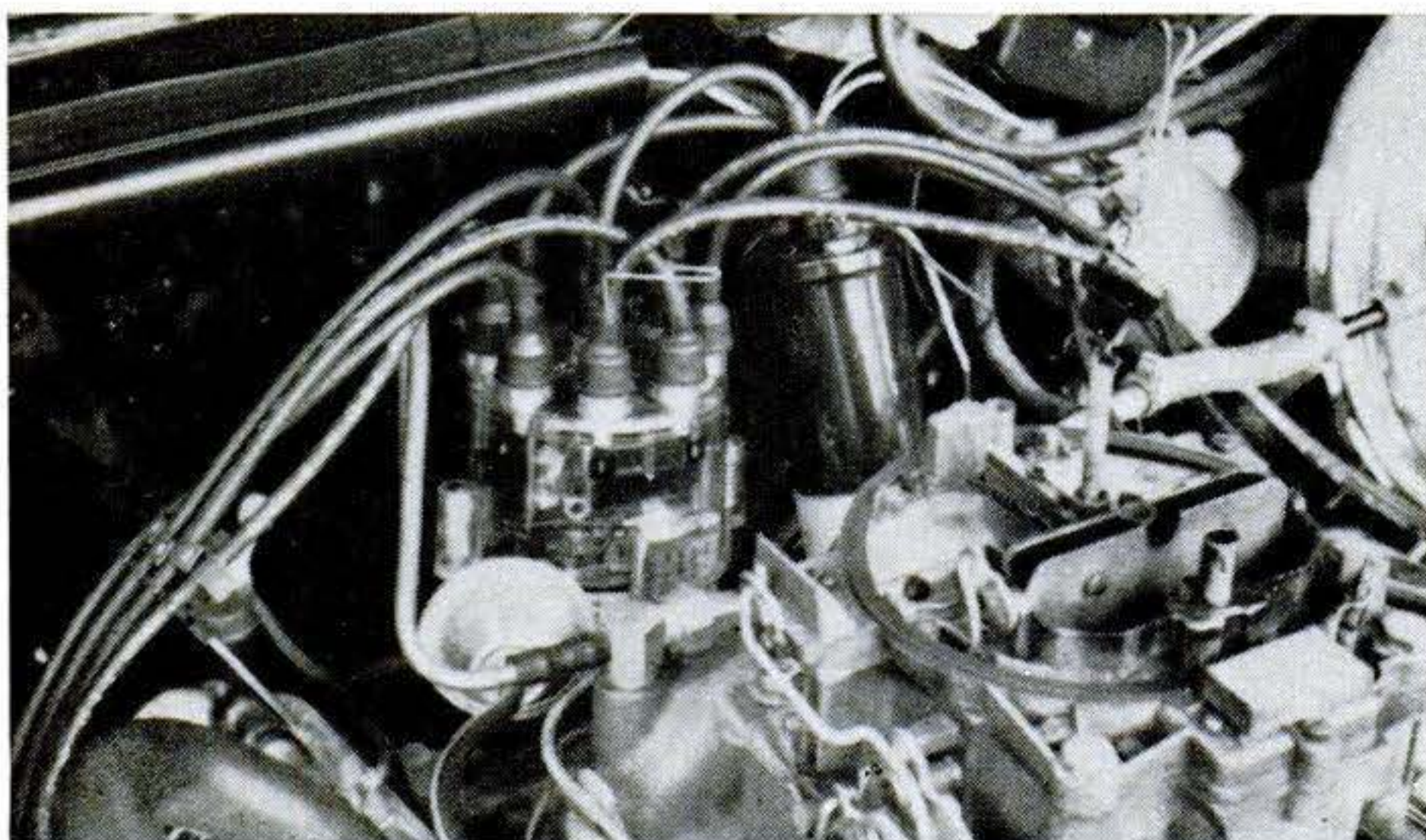
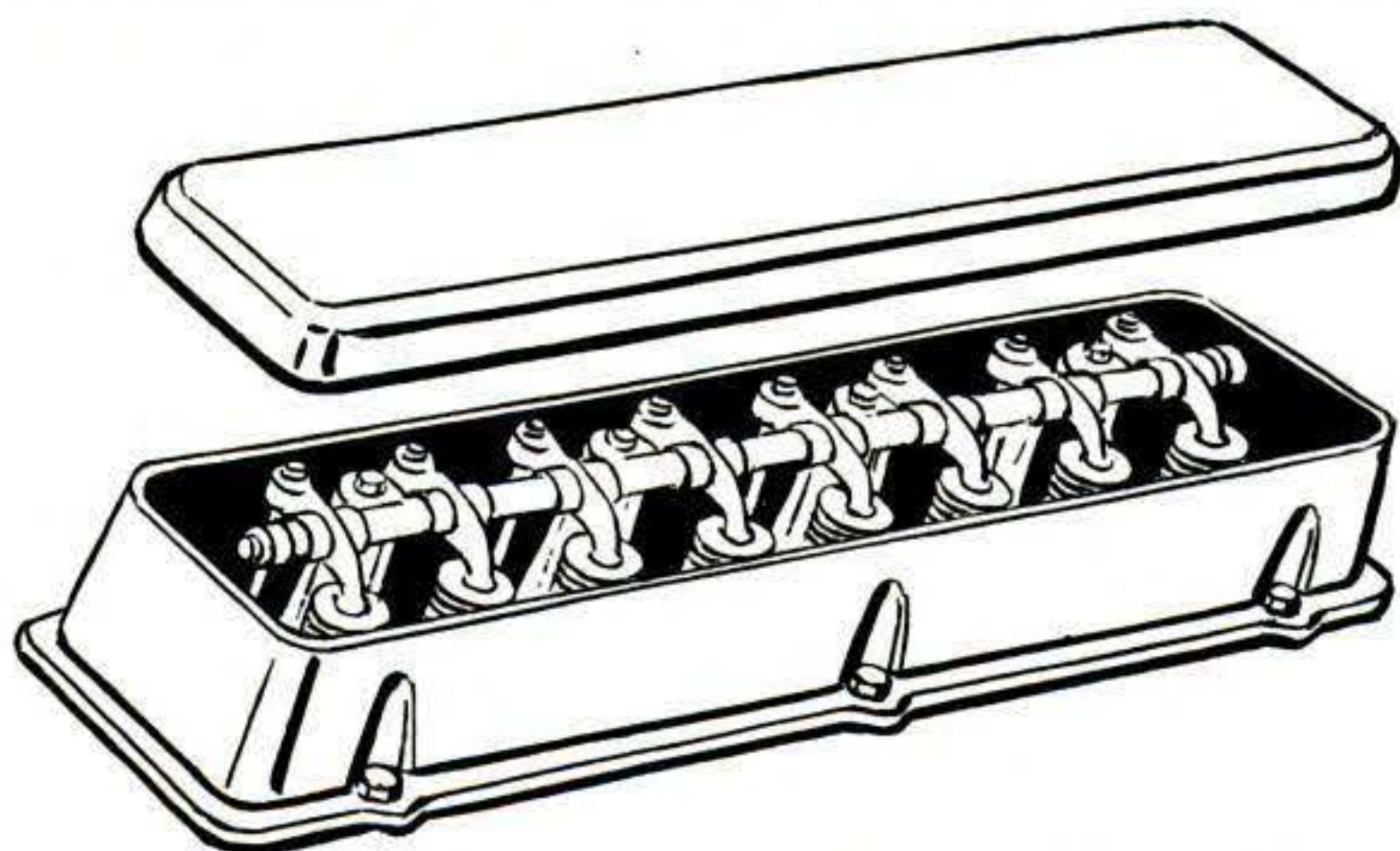


Oil-filler funnel

The oil-filler neck on some car engines is placed so that spilling oil is almost unavoidable. A convenient funnel for engines with limited access space and/or low oil-filler necks can be made by simply cutting the bottom out of an empty Heet or "dri-gas" can.

Avoid losing oil

While adjusting the valve lash on V-8 engines, the messy problem of oil running down the sides of the block and onto the exhaust manifolds can be averted by using a salvaged rocker cover with its top cut out. The rocker-arm adjustment nuts are readily accessible while the sides of the dummy cover keep oil inside of the engine.



Timing-light hookup

A short, stiff wire slipped inside the boot of the No. 1 spark-plug wire at the distributor cap provides a quick connection for a timing light. Not only is this more convenient, but it also avoids damage to the insulation on the timing-light wires that could result from contact with hot exhaust manifolds, and possible breakage of the carbon-core spark-plug wire when removing it from the plug to attach the timing-light connection.



400 watts can drown out the roar of Niagara Falls. A Delco Energizer can produce nine times that power to start your car.

We stationed a group of musicians right at the base of Niagara Falls. All nine of their amplifiers were powered by a single R-71S 12-volt Delco Energizer. Their music came through loud and clear, despite the roar of the falls.



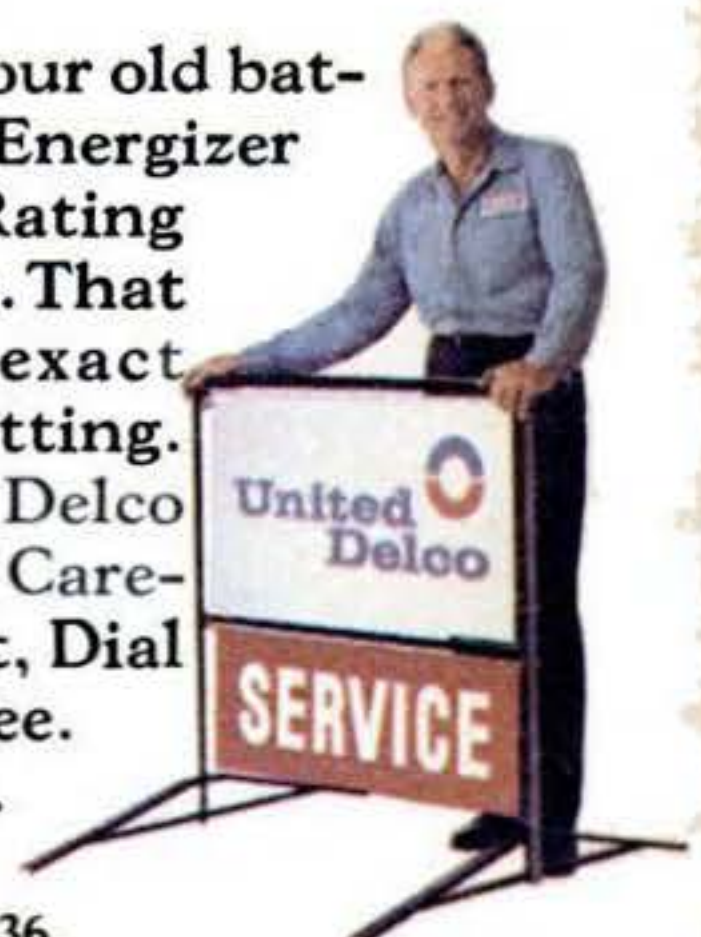
The Energizer used is the same type that can produce, at zero degrees, up to 3600 watts of cranking power in the first few seconds of starting. To give you the biggest, fastest burst of starting power Delco's ever

developed for your car.

When you replace your old battery, ask for the Delco Energizer with the Peak Watts Rating molded right in the case. That way you'll know the exact cranking power you're getting.

See your United Delco Serviceman. He's a real Care-taker. To locate him fast, Dial Delco: 800-243-0355*. Free. Or just look for this sign.

*Dial as for long distance. In Conn., call collect 325-4336.



See the Care-taker.

Electronic Watchdog in a Can

By RUDOLF F. GRAF
and GEORGE J. WHALEN

You probably can't afford to hire your own personal Pinkerton man. But if you'd still like a measure of security while you sleep, here's news: You can build your own electronic security alarm.

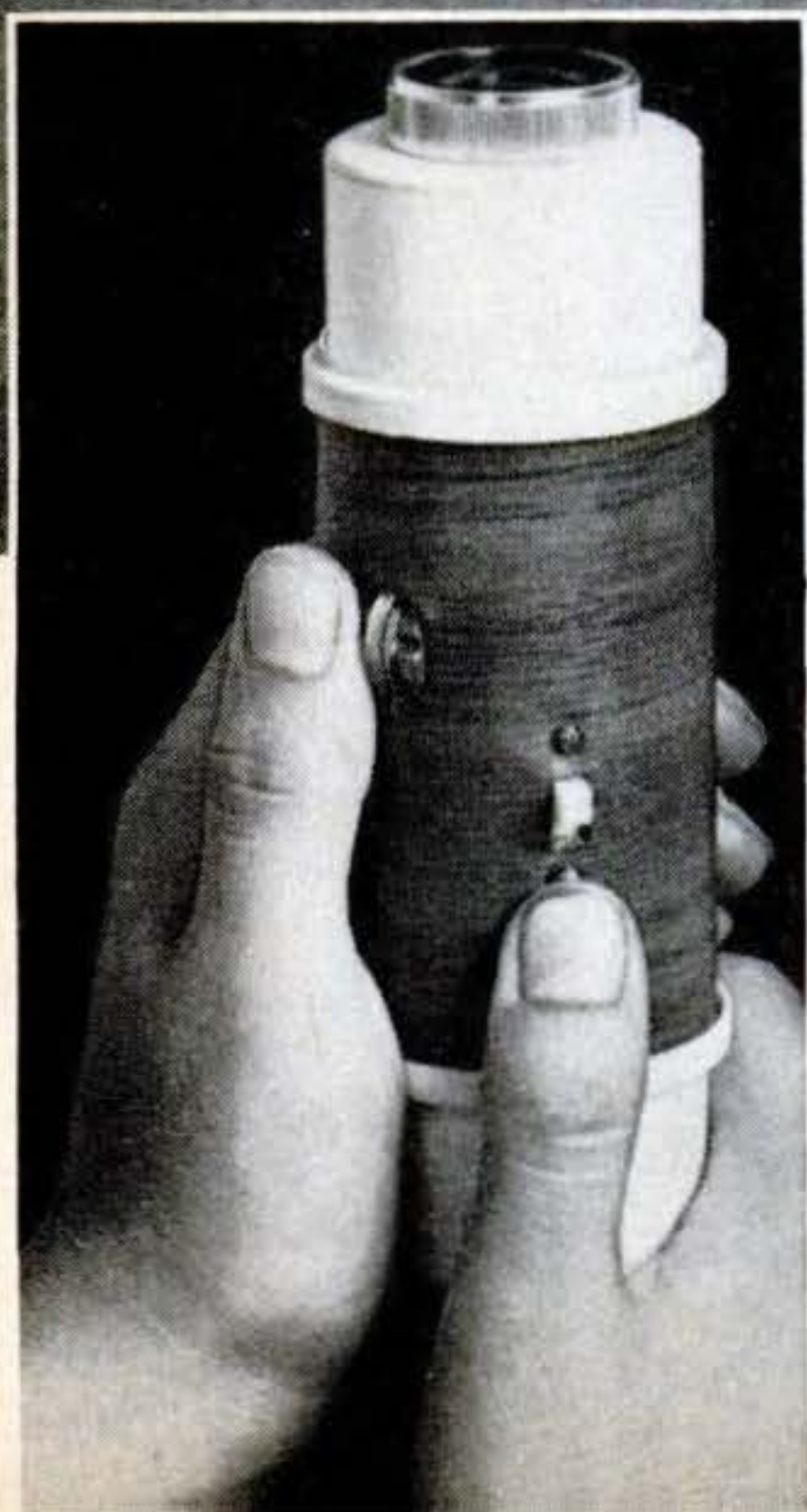
It's a little cylindrical device that measures no more than two inches in diameter and about six in length. It sounds an alarm if someone enters your room while you sleep—and only you can shut it off.

How it's used. The alarm is just the size for packing in your suitcase. Once you arrive at your destination, set it up in your hotel or motel room to guard your belongings against intruders. You can also stand it on top of your suitcase when you must duck into a phone booth to make a call; you'll be warned at once if someone attempts a snatch.

Aside from the doorway use pictured at the left, you can set the unit on a windowsill or on the floor in the middle of a hall—anywhere an intruder might inadvertently knock it over in the dark. By attaching a simple trip wire to the unit you could booby-trap a fairly large area.

When triggered by an intruder, the unit emits a loud, continuous series of audible beeps. The alarm will sound whenever it is jarred, knocked over, or moved from the posi-

Continued



Placed by a door—whether at home or in a motel room—alarm will be tipped over by anyone who tries to enter. This triggers a loud beep that can only be silenced by touching mercury-switch case and screw of on/off switch with moistened thumbs, as shown at left. And—to make it tougher for anyone to figure out—the switch must be at “on”.

for a winning weekend

what kind of power play do the pros call?



Do what the pros do... start a string of winning weekends on Safari, the all-family fun machine from Wheel Horse. Lion or Viking, Packer or Bear... the NFL Pros know that winter's a whole new ball game with Safari.

WHEEL HORSE

*pick of
the pros*

POWER



Escape this winter with the pros, swiftly, safely, surely... on Safari. Call the play with 18 to 30 horses huddled under that bright red hood. Burst on the winter scene on Safari's shock-absorbing, multi-leaf suspension and fly with power (295 to 437 cc.'s) to spare... Kohler engines hide up front over wide-stance extra-wide skis for sure-footed stability. No-fumble refueling with demountable gas tank is hazard-free. Our six new snowcruisers kick-off with dash-mounted starters... let you play night games with 18,000 candlepower dual headlights. One, two or three can hike the highlands on Safari, with storage room for half-time snack or chow-down. All-American parts and service everywhere with 3,000 Wheel Horse dealers rooting for you. You'll fall in love with winter with Wheel Horse, when you go like the pros... swiftly, safely, surely on Safari.

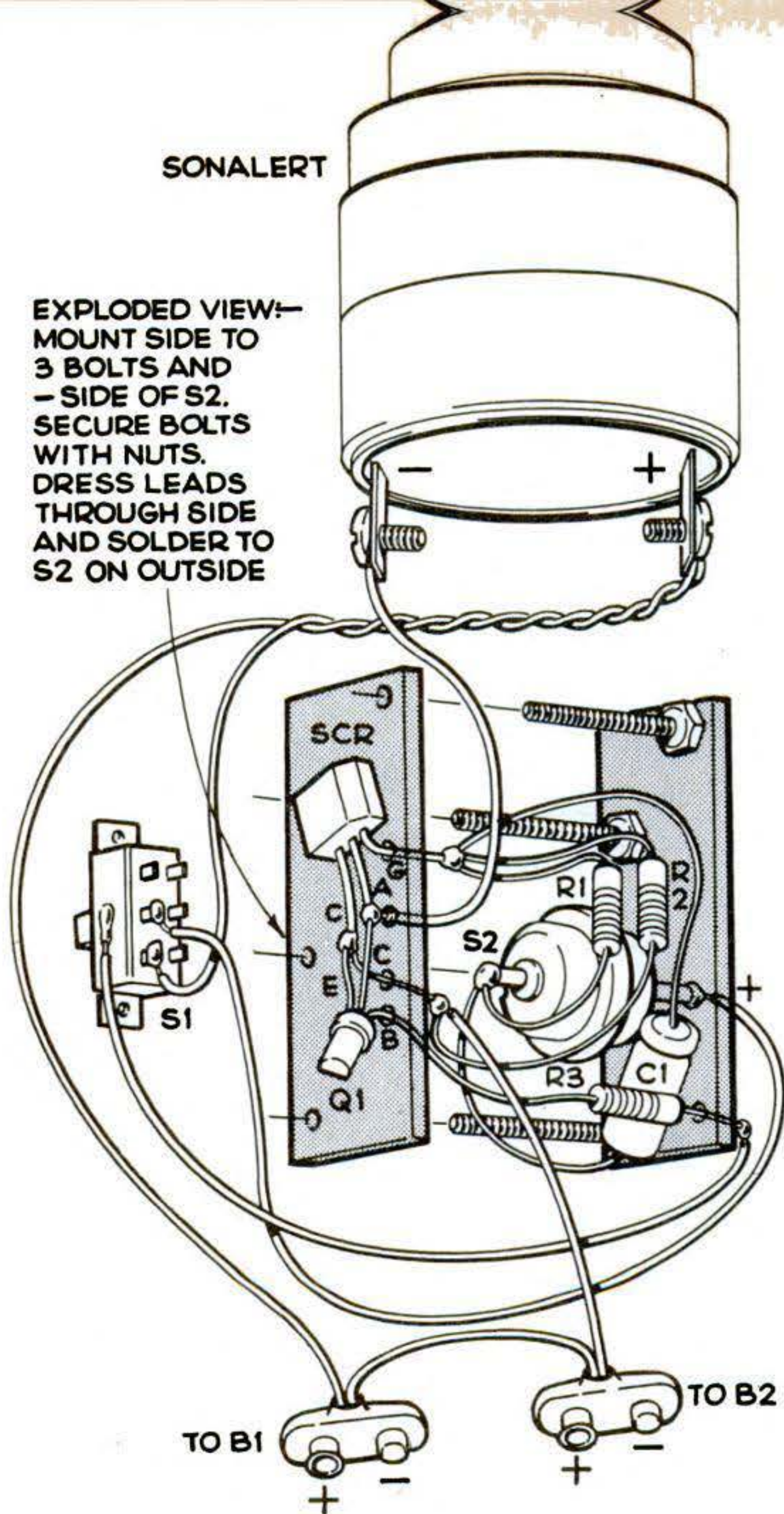


SAFARIS ARE BUILT BY SNOW-MOBILE PIONEERS/ RUGGED AS ANY WHEEL HORSE TRACTOR.



Look under "Lawn Mowers" in Yellow Pages for nearest dealer or phone 800-243-6000 free. In Connecticut call collect 853-3600.

Tractors/Mowers/Snow Throwers/Snowmobiles



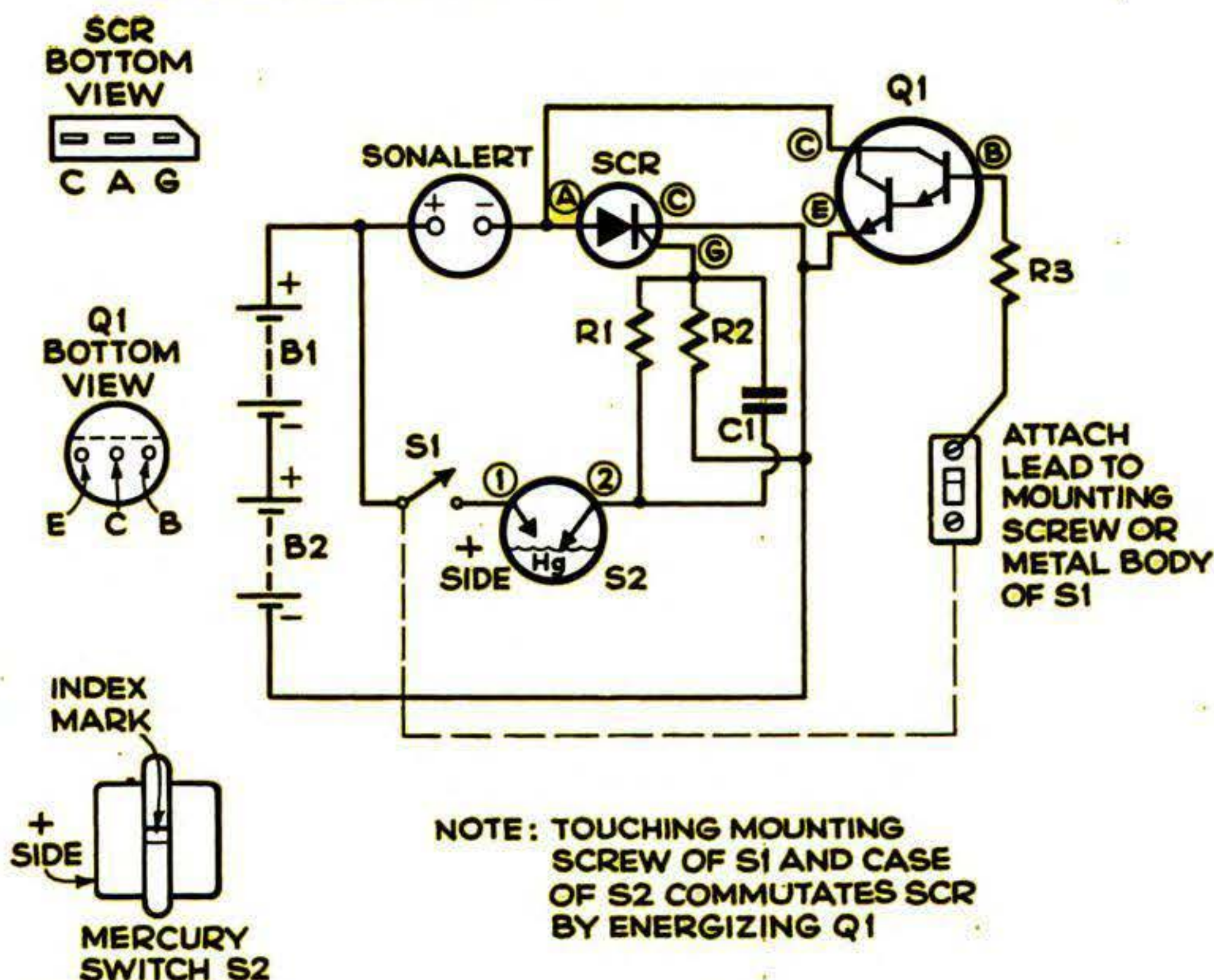
tion in which you left it. Once it is triggered, the alarm cannot be turned off by anyone who is not aware of the secret way to deactivate it.

How it works. The alarm signal is produced by a pulsating Sonalert, activated through a silicon-controlled rectifier and powered by two nine-volt alkaline batteries connected in series. The intrusion sensor used in the security alarm is a mercury switch. This type of switch consists of two normally open contacts that are closed when a blob of liquid mercury lies between them; in this case a momentary contact is sufficient to close the switch and trigger the SCR.

Once the SCR is turned on, it applies power to the Sonalert and "latches on." The SCR will not normally turn off unless it is commutated. This is accomplished in our device by the use of a Darlington amplifier touch switch.

Because the Darlington amplifier is such a sensitive device, very little current is required at its base to turn it on. That is the secret of the security alarm: The

Continued



PARTS LIST

- B1, B2—9v alkaline battery (Mallory MN-1400)
- C1—0.1 MFD capacitor (Sprague 192P)
- Q1—Monolithic Darlington transistor (GE 2N5306)
- R1—1-meg., $\frac{1}{2}$ -watt $\pm 10\%$ carbon resistor
- R2—1-k., $\frac{1}{2}$ -watt $\pm 10\%$ carbon resistor
- R3—39-k., $\frac{1}{2}$ -watt $\pm 10\%$ carbon resistor
- S1—miniature slide switch (Lafayette 996186)
- S2—mercury element (from any GE wall-type toggle switch)
- Misc.: Sonalert (Mallory SC628P); SCR (GE C106Y2); 2"-dia. plastic spray-can tops; 2"-dia. x $3\frac{1}{2}$ " juice can; wire, solder.



BOLENS HUSKYS— GREAT WAYS TO RETIRE YOUR SNOW SHOVEL.



Bolens Husky Arctics

Both the 5 and 7 hp Huskys are built with a big appetite for snow. Both models have 4 forward speeds plus reverse to tackle anything from a snow shower to a blizzard. Electric starting is optional on either. And an exclusive adjustable differential on the 7 hp Husky matches pulling power to ground conditions. Visit your Bolens Husky dealer. He'll show you how to take the work out of winter.



Bolens Husky Tractor™ with Snow Caster

With a Bolens Husky, you're not only ready for winter, but also for lawn and garden work when spring comes. The snow caster attaches easily and blasts away snow at up to a two-ton-a-minute clip. A single "Go-Go-Pedal" controls forward, reverse, speed, and power braking. Your hands never leave the steering wheel. See your Bolens dealer soon. He makes it easy to retire your snow shovel.

The Bolens Husky team...compact tractors • riding and walking power mowers • tillers • snow casters • snowmobiles



BOLENS

BOLENS DIVISION, FMC CORPORATION, PORT WASHINGTON, WISCONSIN

connection from the base of the Darlington to the plus terminal of the battery is made through your fingertips.

Setting it up. By holding the unit as shown on the opening page, an infinitesimal amount of current is supplied to the base; the device turns on and commutates the SCR. To turn the alarm off, you must hold it in an upright or other predetermined position, and the travel switch must be on. No sneak thief will hang around for very long with an alarm sounding off that he cannot silence.

The on/off switch is needed so that the device can be kept in a deactivated state during transportation. Once it is put into the proper spot, and the switch is turned on, the alarm is armed. Any jarring or movement will turn the SCR on, and start the blasts. Now, if somebody picks it up, they will naturally want to turn it off by sliding the switch to the off position. Once they do this, they've had it. No matter what is tried, this device can never be turned off with the switch in the off position. Only *after* it is properly silenced do you slide the switch to the off position so you can move the security alarm any which way you like.

It's easy to make. The unit is housed in a frozen-fruit-juice container, which is covered with some appropriate contact paper, capped by two 2"-diameter plastic spray-can tops. One of the tops has a hole for mounting the Sonalert; the other raises the center of gravity and provides a

slightly rounded bottom to make the security alarm easier to tip over.

The mercury element is one from any General Electric mercury wall switch, available in most hardware stores. The switch is taken apart and the mercury element is removed. This element is mounted between two small perfboards, and contact is made through the heads of two binding-head screws that fit into the small concave spaces on each face of the mercury element. In the exploded diagram, these screws are seated and wired as they will appear *after* assembly of the boards. The heads are *not* attached to the element, which turns freely between them. The two boards are spaced approximately 5/8th of an inch apart and held in place by three screws which exert the proper pressure on the mercury element.

Two openings are cut in the container. One allows the mercury-switch element to protrude to permit position adjustment, the second is for the slide switch. The housing of the slide switch is connected to the Darlington amplifier as shown in the schematic.

Fruit-juice cans are usually lined with a metal foil. In order to be sure that there are no shorts, place some insulating tape on the inside of the container. The two batteries serve to hold the perfboards in place, making for a very compact assembly. Note that the batteries are half way up in the container, giving a high center of gravity for easy tipping. PS

TO CHECK YOUR WIRING					
VOLTAGES				RESISTANCES*	
FROM	TO	STANDBY VOLTS	ALARM-ON VOLTS	POS. LEAD TO	READING
SCR Ⓐ	SCR Ⓢ	17.5 ± 0.5	0.15 max	SCR Ⓐ	1.7 meg
SCR Ⓢ	Common	0	0.54 ± 0.06	SCR Ⓢ	1000
				SCR Ⓢ	0
Q1 Ⓢ	Q1 Ⓔ	17.5 ± 0.5	0.15 max	Q1 Ⓢ	1.7 meg
Q1 Ⓢ	Q1 Ⓑ	0.02**	0	Q1 Ⓑ	Inf
				Q1 Ⓔ	0
S2 ①	Common	17.5 ± 0.5	17.5 ± 0.5	S2 ①	1.5 meg
S2 ②	Common	0	17.5 ± 0.5	S2 ②	1.5 meg
				S1, case	Inf
Sonalert ⊕	Sonalert ⊖	0.02	15.5 ± 0.5	Sonalert ⊕	1.5 meg

**Sonalert may sound when probes are connected.

*With S1 closed, B1 and B2 disconnected; neg ohmmeter lead connected to common

NOTES: Unit vertical (mercury switch open) for Standby readings; tilted 90° for Alarm-on.
Readings taken with 100,000 ohms-per-volt DC multimeter (Lafayette 99-5065).
Anode-to-gate SCR voltage can't be measured without triggering alarm.



**Take it
from people
who know,
ski-doo is the one
rugged enough
to conquer
the pole!**



Last year, four men on Ski-Doo snowmobiles rewrote a page of history. For 44 days, they faced the worst the Arctic could offer. 835 miles later, the U.S. Air Force told them "You've reached the North Pole. Wherever you go from here is South".

If a snowmobile can take that kind of punishment, it has to be good. But being good isn't good enough. Once again, we've gone all out to go one better than the rest.

Better performance. Ski-Doo has more dependable power for climbing, towing, funning around.

Better ride. Smoother over the bumps. More stable in the turns. And no snowmobile is so light-footed — over deep, deep snow.

Better selection. For 1970, we offer five Ski-Doo series, each with a totally different personality. If it's luxury you're after we have it. If it's economy, we have a Ski-Doo so low-priced, many people are buying two.

If you want the number one choice in snowmobiles, in high fashion winter sportswear and accessories, see your Ski-Doo dealer. He'll show you the 1970 reasons why you go one better when you go Ski-Doo.

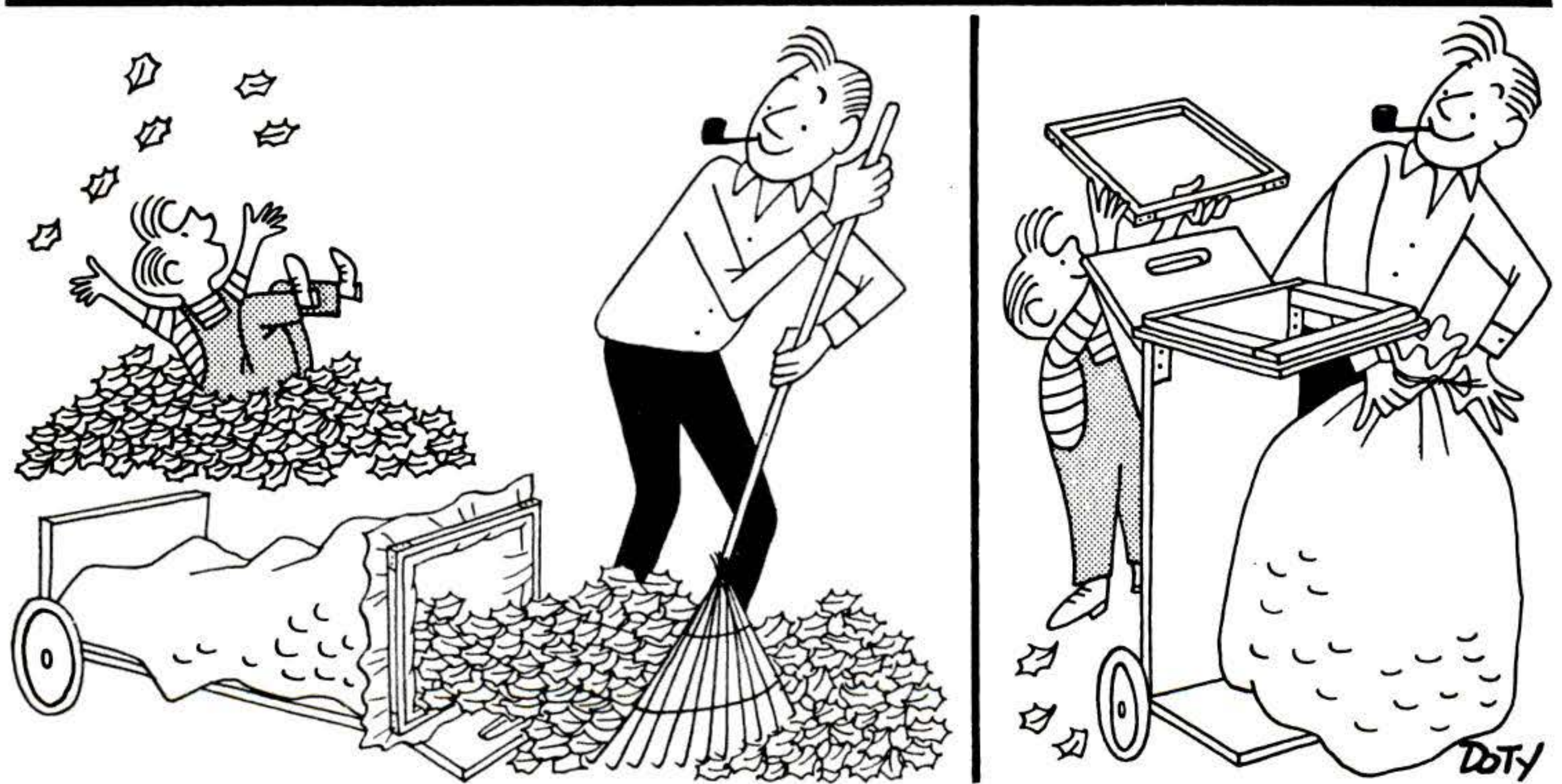
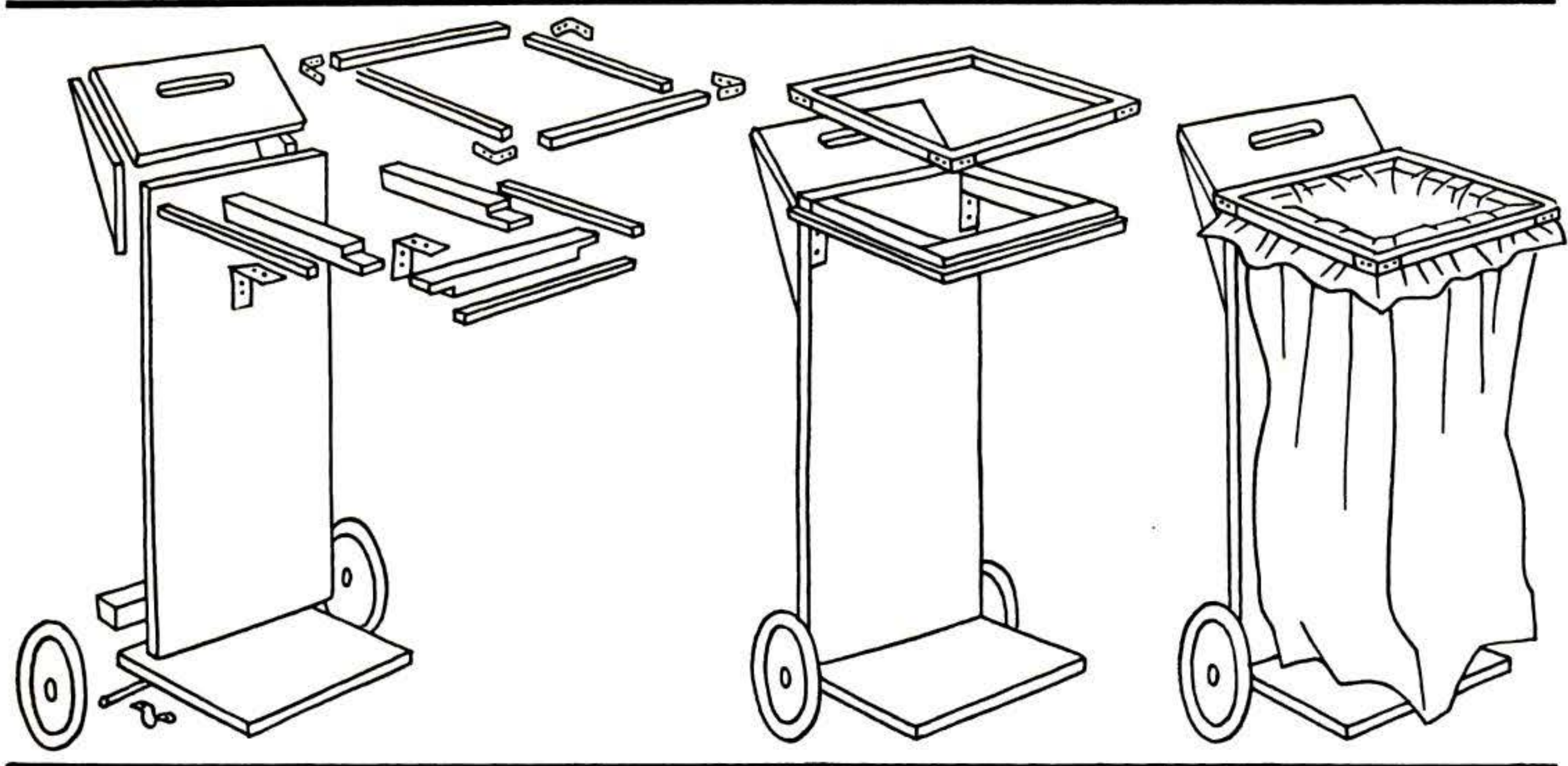
**no one better
go ski-doo**
North America's number one snowmobile



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MEADVILLE, PA.

What It's Like to Fly the Jet Belt

[Continued from page 59]

It weighs about 125 pounds, with its hydrogen peroxide tanks full. To obtain thrust, this nitrogen-pressurized propellant is forced through a silver catalyst screen that decomposes it into superheated steam—which is ducted through insulated tubes and exhausted from twin nozzles.

Flying platforms—and a lunar vehicle. Working toward development of a Lunar Flying Vehicle for future moon-exploring missions, Bell engineers adapted the proven Rocket Belt propulsion unit and control system to a series of one-man and two-man flying platforms, including both sit-down and stand-up versions. Known as the "Flying Chair" and "Pogo," these vehicles were built and successfully flight-tested within the last four years.

Under contract with NASA, we're now designing the Bell Lunar Flying Vehicle, whose rocket engine will be fueled by Lunar Module propellants. This proposed moon taxi will carry an astronaut, wearing his Apollo spacesuit and backpacked Portable Life-Support System, up to 15 miles on lunar-exploration flights.

Rocket thrust is effective in any environment and is ideal for flying in space or touring the moonscape—but it's very inefficient in the earth's atmosphere. The Rocket Belt's limited 300-yard range and 21-second endurance in earthly flights show the need for the improved capabilities that the Jet Belt now brings.

Midget fanjet is key. What makes the Bell Jet Flying Belt possible is the new WR-19 bypass gas-turbine engine designed and developed for it by Williams Research Corporation of Walled Lake, Mich.

This miniaturized fanjet engine is only a foot in diameter and two feet long. Yet it has the high thrust-to-weight ratio and efficiency available before only in large engines.

Intake air is divided into two streams. Part is channeled through a peripheral duct bypassing the engine's combustion chamber, and then is mixed with the heated gases of the engine's exhaust. Besides adding to the engine's thrust, this bypass air insulates the operator and fuel tanks from engine heat, and lowers the temperature of the exhaust.

Gyroscopic forces during maneuvers are minimized by another major design feature of the engine—its arrangement of moving components in twin counterrotating spools. A centrifugal compressor and first-stage turbine turn in the opposite direction from fan and axial-compressor rotors and second- and third-stage turbines (see diagram).

Mounted vertically with inlet down, the engine exhausts through a bifurcated duct to twin downward-pointing nozzles just behind the flier's shoulders. The gimbaled nozzles, which can be deflected in the same direction or in opposite ways by different controls, provide lifting thrust and forces for maneuvering.

Two wraparound fuel tanks of translucent plastic, interconnected for common fuel level, hold the kerosene-type (JP-4) jet fuel. A reserve-fuel-level warning—a vibrator in the pilot's helmet—is actuated when a float in the left tank falls to a preset level.

Belt has a chute. A parachute system, packaged atop the demonstration model of the Jet Belt, has proved its ability to land a pilot safely under the most adverse conditions for its deployment—from hovering flight as low as 65 feet. It consists of a paratrooper's standard emergency chute, deployed by a drogue gun.

A standard, Army two-way field radio provides air-to-ground and ground-to-air communication. Sensors continuously give the pilot engine data through an on-board display. During test flights a battery-powered telemetry system transmits the same data to a ground station for display and recording.

The complete back-packed Jet Flying-Belt system is mounted on a fiberglass "corset" that puts most of the weight on the pilot's hips, where it is most easily supported. A suspension harness and shoulder straps keep everything secured.

Flying-platform versions of the Rocket Belt—Pogo, Flying Chair—are considered adaptable to the new jet-powered system, too.

All this will give you an idea of the possibilities of Bell's remarkable new individual-mobility system—which bridges the gap between ground vehicles and conventional airborne travel. PS



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Thrills in Taking a Test Flight

[Continued from page 140]

ing the nose up. The engine labored to lift the ship. The airspeed indicator began falling . . . 90 . . . 80 . . . 70 . . . I drew back further on the wheel to hasten the stall. At 60 m.p.h., a shriek from the stall-warning horn told us the airplane would be critical in seconds.

Now the ship was hanging in the sky by its prop. A shudder rippled through it as smooth air tore away from the wings. The plane had stopped flying. As it dropped, I began the recovery. I quickly lowered the nose and rammed the throttle to the firewall to apply full power. Airspeed climbed above 55 m.p.h. and we were flying again.

Instrument-flight test. McAdams next handed me a hood to narrow my vision to the instrument panel only. Now he'd check my flight maneuvers when I couldn't see the actual horizon. After I'd turned, climbed, and descended by watching the artificial horizon, he said, "I've got it," and took over the controls.

Now there would come an exercise called *recovery-from-an-unusual attitude*. As McAdams said, "Okay, you've got it," I glanced at the instruments and could hardly believe the indications. The miniature airplane on the artificial-horizon dial was pitched at a steep angle, its wings nearly vertical. I had the uncanny sensation that I couldn't "feel" the plane's weird attitude. It disproved the widely touted seat-of-the-pants idea about flying blind. I ignored my wallowing inner ear and forced the tiny plane on the panel into level flight.

"Now take me to Kingston," asked McAdams. The hood still limited my view; this would be more of the instrument phase. Once you demonstrate normal flight by looking at the dials, then you have to go somewhere. I tuned in the Kingston beacon station on the radio and fiddled with the knobs until the word *TO* appeared in a window. Then it was simply a matter of centering an indicator needle to keep the plane headed toward the station. After flying the course several minutes, the *TO* switched to *FROM* which meant we were flying directly over the Kingston station. It was a relief to remove the hood.

I had made it to the final obstacle: the cross-country phase. I had been instructed

earlier to plan a trip to Wilkes-Barre, Pa., some 100 miles away. We'd begin the trip and fly enough of it to satisfy him that it could be flown safely. A successful cross-country is not in flying but in planning.

On my very first cross-country with an instructor, I missed whole cities. I had added a wind-correction angle, instead of subtracting it from the course. On another flight, I pulled a Wrong-Way Corrigan, flying due east, misled by a faulty compass. "But you should have known it," my instructor insisted. "The sun was in the wrong place!"

After 10 hours of solo cross-country, my skill had sharpened and I could find small, obscure airstrips. As we flew the first 10 minutes on our way to Wilkes-Barre without a hitch, I knew the test would soon be over. I got the flutters again.

Short-field landing. Back over Stormville, McAdams decided to toss in this valuable maneuver for postage-stamp fields, where the roll-out must be short. As the plane descended into the airport traffic pattern, I mentally reviewed the steps for a short-field landing: extend full flaps, reduce airspeed to . . . OMIGOSH!

I was about to blow the test by landing the wrong way. I'd caught sight of another airplane landing to the east. I was approaching the same runway for a westerly landing. Did I misunderstand instructions from the ground? McAdams answered that by grabbing the mike and barking his displeasure at the wrong-way landing of the other guy.

Now I was clear for the last maneuver. Flaps were down for maximum drag . . . power pulled off, airspeed slowed to under 60. Aerodynamically, the craft was now in its "dirtiest" condition—lowering rapidly, not picking up forward speed.

"I know the book says only 58 m.p.h. for this maneuver," said McAdams, "but we like to keep airspeed a little higher. We don't want to hit that snow bank at the beginning of the runway." When the plane stopped, he got out without a word and trudged to the office.

Maybe I should forget flying and try antique collecting, I thought as McAdams grabbed a paper and started typing. Then I caught sight of the two heart-thumping words on it . . . *Airmans Certificate*. **PS**

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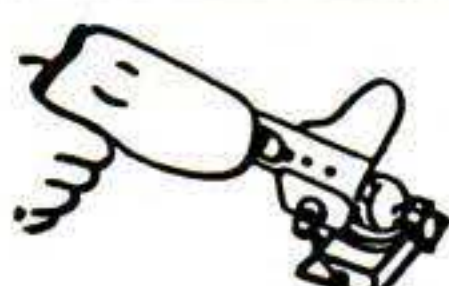
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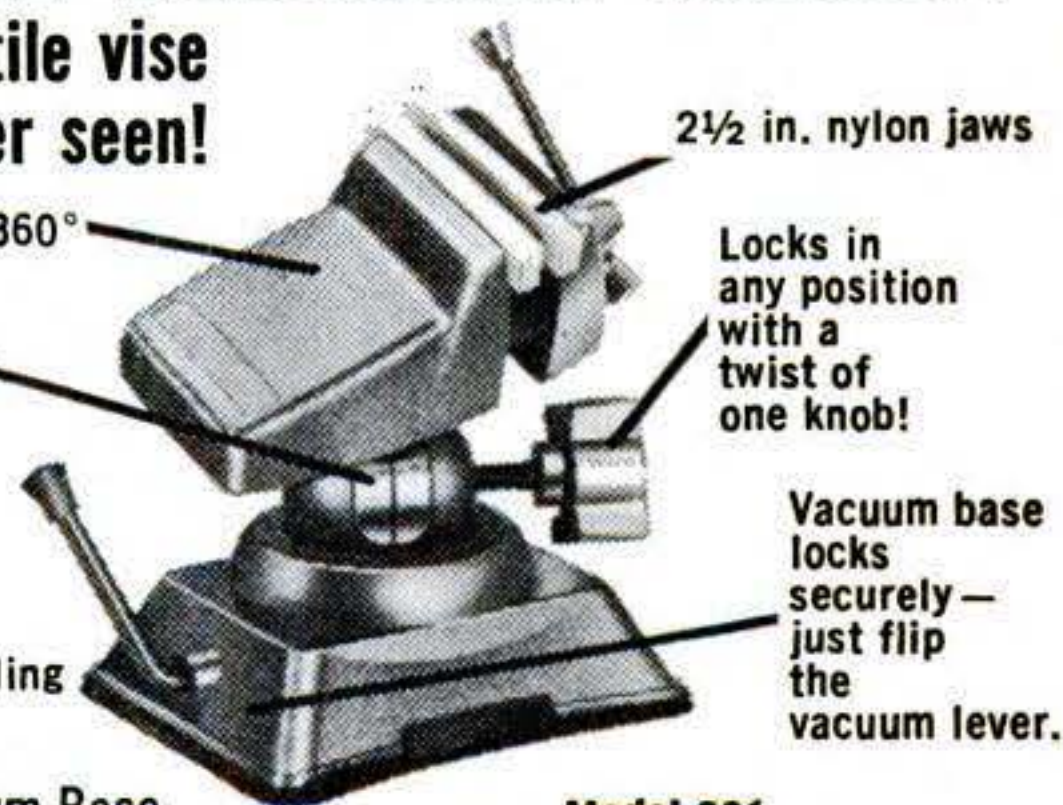


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Model 301

A Colorimeter You Can Build

[Continued from page 166]

In many daily situations we have control over the first two factors. For example, you can choose the color of paints used throughout your home; you can select the type of artificial lighting in your house; and you can select the character of surfaces that will be painted.

Unhappily, our eyes are not the best test instruments for studying these factors—that's why the colorimeter was invented. Because it has no brain, it isn't prone to the optical illusions our seeing system falls prey to.

The colorimeter is basically a sensitive photoelectric light meter (similar to a photographer's exposure meter) that is equipped with three color filters that can be placed in front of the photocell. Any brand of meter and filter will work. Buy the least expensive you can find. The filter numbers specified in the parts list are not stocked by many photo stores, but can be ordered for you. One manufacturer that makes all three is Tiffen Optical Co., 71 Jane St., Roslyn Heights, N.Y. 11577.

When a red filter is placed in front of the cell, the reading is proportional to the amount of red light frequencies in the light striking the instrument. Thus, if the colorimeter is pointed at a colored object, three successive readings—one with each of the filters in place—will give the relative intensities of the red, green, and blue components in the light reflected by the object.

Building it. The instrument's case is a small aluminum minibox. Mount the panel meter and sensitivity control (R2) as shown in the diagrams. Cut a one-inch viewing port for the photocell in the front end of the box, and cement the cell in place, using epoxy.

Series-type filters are designed to fit into a two-piece holder that screws into a camera lens. Cement the rear half of this holder over the photocell viewing hole.

Cement a 1/4-20 nut over a hole cut in the bottom of the box to let you mount the instrument on a photo tripod. This is important for anchoring the unit so that its photocell scans an object exactly the same way during successive readings with the three filters. If you don't use a tripod, be sure to clamp or tape the unit in place during tests. PS

Snowmobiles Come to the Suburbs

[Continued from page 136]

To gain experience with loading and unloading my borrowed snowmobile, I borrowed a pickup. Using an old six-foot-long door as a ramp, we easily drove the machine up into the truck bed, pushing a bit to overcome slippage. With this improvised ramp, I could also unload the snowmobile without help. On the basis of this experience, I developed a portable ramp from a sheet of 3/4-inch plywood.

This homemade ramp might also be suitable for loading a snowmobile into some of the larger station wagons. For this, however, you might have to add helper springs. The weight of a snowmobile (500 pounds or more) makes the usual wagon rear-heavy, and you should keep speed down for safety.

A conflict of interest has already developed between snowmobile users and some other outdoorsmen. On frozen lakes or streams, you can run afoul of ice fishermen by speeding too close to their tip-ups. At many ski slopes, you'll find yourself unwelcome. But state and national parks now have snowmobile trails. Check those in your area. Clubs also are springing up throughout the snow country that make it their business to collect such information. Individuals with reasonable lengths of private trails are opening them to public use at a charge.

Some machines have no reverse. For permanent ownership of one I'd want to build a special storage shed with doors on opposite sides so I could drive out as well as in. During the past season, we stored the machine where we had to drag it out backwards—and that took at least two persons. During one of these tugging sessions, one of the boys (Peter, I think) came up with a suggestion that I hereby present, gratis, to all snowmobile makers—that they give the back ends of the two steering skis an upward sweep like the front. That way the rear ends of the skis won't dig in and make rearward dragging more difficult. I hope to find this on 1971 models.

That's the year I expect to buy one—if I can successfully withstand the pressures I already feel developing for one of this year's fine output. Maybe I shouldn't fight the pressures. Don't tell my boys. But I'm really not trying *too* hard. PS

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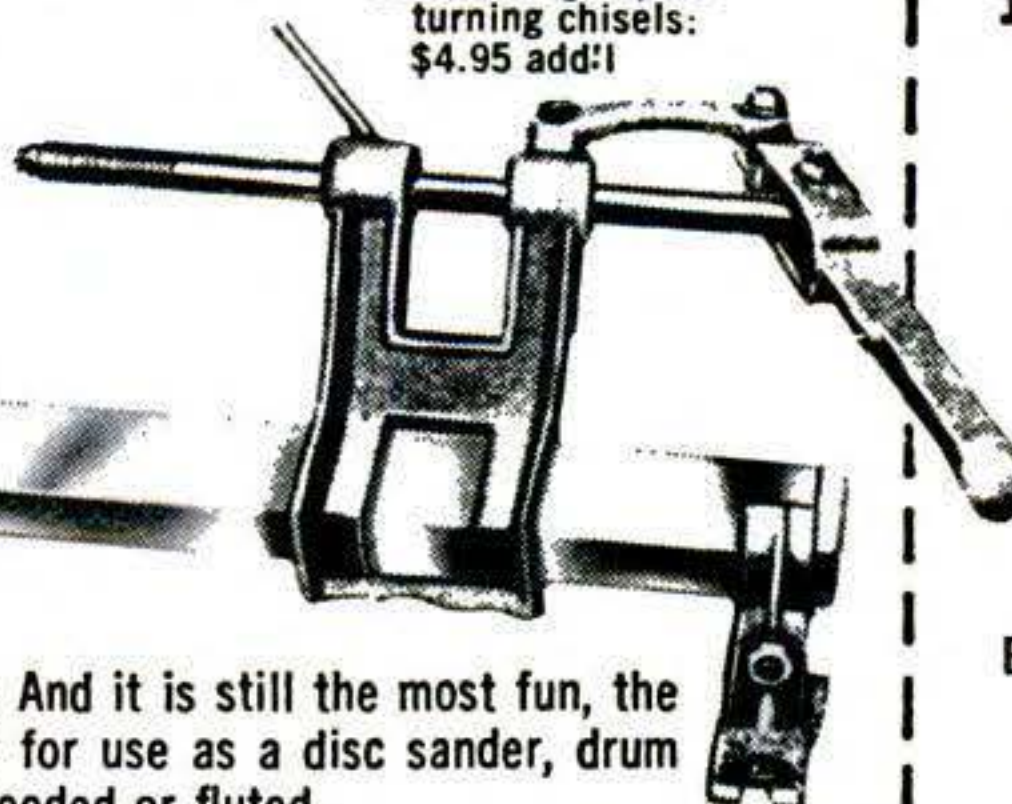
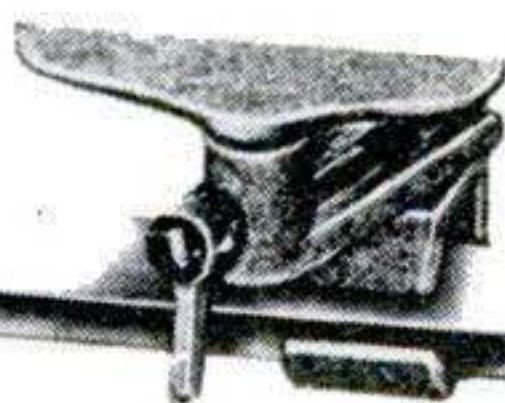
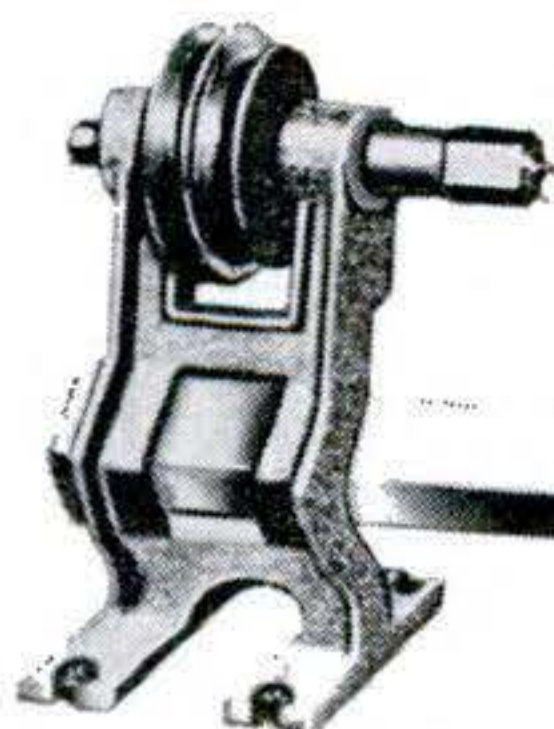
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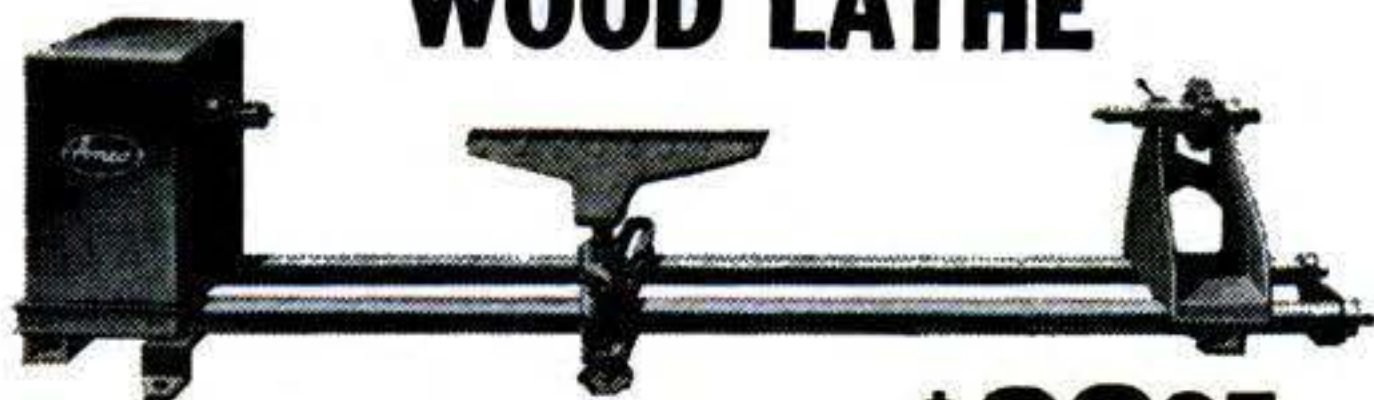


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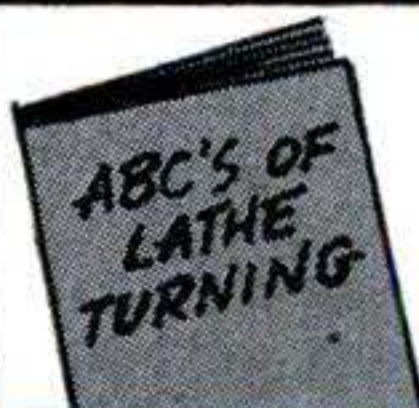
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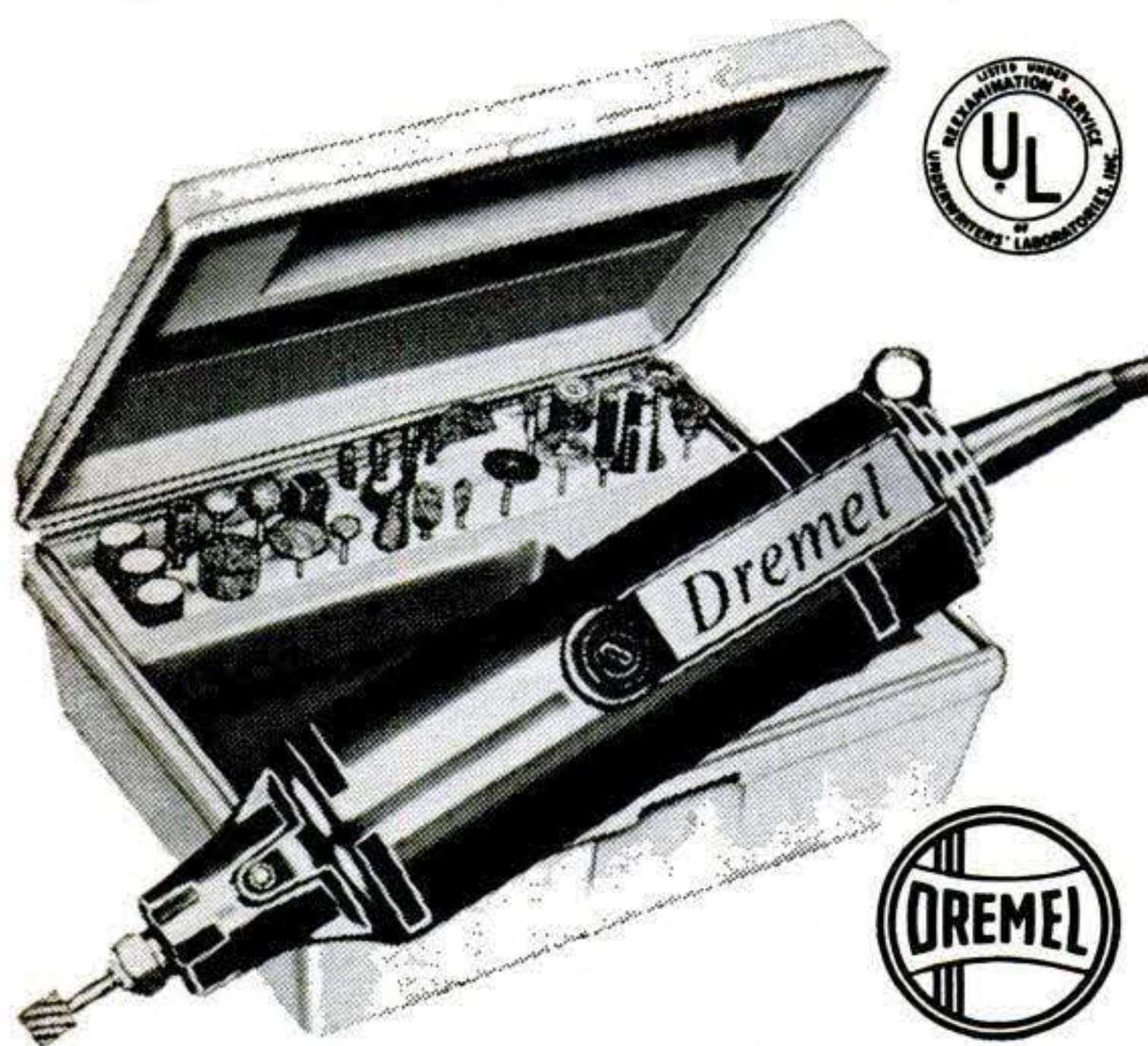
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New Underwater Breathing Systems

[Continued from page 75]

helium must not only be closely controlled, but also varied with depth (pressure).

At 100-foot depth, for instance, a proper breathing mixture could be about five percent oxygen and 95 percent helium. At 650 feet it would be about one percent oxygen and 99 percent helium. (The idea is to keep the partial pressure of the oxygen constant and roughly equal to that in air at sea level, so that the same amount of oxygen is delivered to the body at all depths.)

Helium-oxygen gear. Mixed-gas diving gear of the semiclosed-circuit type provides for maintaining the proper oxygen level, at any depth, by adjusting mixture ratios and flow rates of the gases in the tanks.

Carbon dioxide in the diver's exhaled breath is absorbed by a chemical, instead of being exhausted to the seawater. Exhaled oxygen (which open-circuit gear would also exhaust to the sea) is recirculated. It supplements the mixture entering the inhalation bag from the tanks.

The gear is called semiclosed because about one-third of each exhaled breath is lost through an exhaust valve. While this is undesirable, it is unavoidable with passive control of oxygen concentration. Even so, the gas supply lasts much longer than it would in open-circuit equipment.

Best answer to a deep diver's breathing needs is a closed-circuit device that wastes nothing to the seawater—there are no bubbles, nothing of value is thrown away—and that actively controls the oxygen concentration. With a given gas supply, such a device has 100 times the endurance of open-circuit gear. This electronic-controlled type can be made into a small and compact unit, and several different makes are available.

There is a new closed-circuit mixed-gas breathing unit on the horizon now that represents the aquanauts' cherished hope for deep diving—a cryogenic gear using liquid oxygen. Patented by Halbert Fischel and fabricated by Sterling Electronics, it performs the tasks just described in a different, more efficient, and highly reliable manner.

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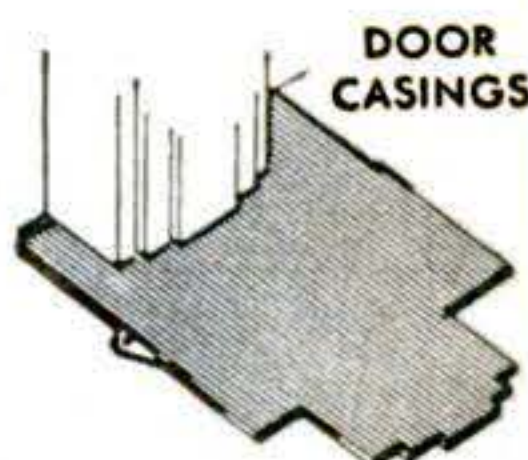
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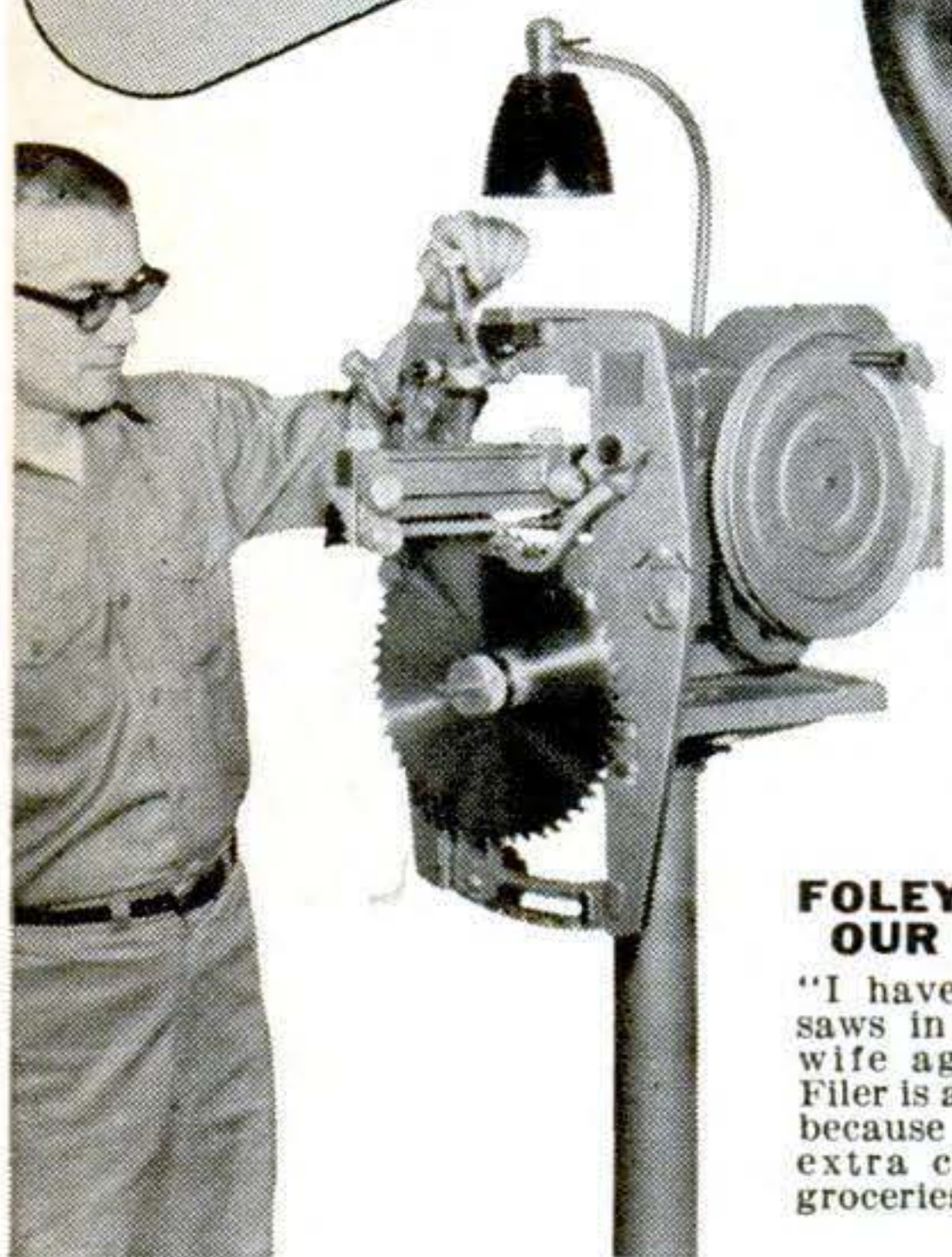
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The new model Foley Saw Filer (shown above) is the first and only machine that automatically sharpens combination (rip and crosscut) circular saws—also all hand saws, band saws and crosscut circular saws. The adjustments are simple—there is no eyestrain—and you can start right away to turn out perfect cutting saws. Exclusive jointing action evens up irregular teeth—old saws cut like new!

"MONEY MAKING FACTS" explains how you can get business from hardware stores, homeowners, farmers, carpenters, schools, mills, factories, etc. Just think, with a modest investment, no overhead, no stock of goods to carry, you can start right in on a cash business that will help pay the rent, buy groceries, or a new car. Time Payments available: send coupon today for this practical money making plan. No salesman will call.



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New Underwater Breathing Systems

perature in the tank is a function of that pressure; the partial pressure of oxygen in the breathing mixture depends, in turn, on that temperature. Thus the oxygen concentration (partial pressure) is directly controlled within very fine limits through the use of spring-loaded boil-off valve.

In a heat exchanger, exhaled carbon dioxide is frozen out, and falls to the bottom as dry ice. Oxygen that is boiled off, to maintain the proper pressure, is consumed by burning with a suitable fuel to provide needed heat for a deep diver.

Improvements ahead. Each type of gear can stand improvement, and refinements are coming. Higher gas pressure will improve units with pressurized-gas tanks. Today, 3,000 pounds per square inch is a maximum for scuba; soon we'll store divers' air at 7,000 pounds' pressure.

When breathing equipment provides unlimited endurance in the water, deep divers will have to contend with a problem that usually limited our Sealab II dives to less than an hour:

The formidable cold of the deep ocean can numb the body and mind of a man staying longer—even to the point of helplessness and amnesia—unless countered by some artificial-heating device. Already the first steps toward heated diving gear are being taken.

I was one of a number of Sealab II divers who tried out an experimental version of an electrically heated diving suit. Resistance-wire elements drew current either from silver-zinc batteries on the user's belt, or through a cable from the Sealab. The heated suit enabled one aquanaut to stay comfortably in the cold water for almost three hours; but faults such as breaking heating wires made it unacceptable.

Currently, the Navy has a hot-water-heated suit for tethered divers, with the heated water supplied through an umbilical. A self-contained hot-water heater for a diving suit, using radioactive plutonium as a heat source, has also been devised. But perhaps the ultimate solution may be a chemical-fueled heater like the one built into the closed-circuit cryogenic breathing gear, described earlier.

Today we visit the shallow depths of the sea. Tomorrow, with the development and refinement of scuba gear, we shall live in the great depths.

PS

Shop Power at Your Fingertips

[Continued from page 127]

off a drill press or similar power source. It would be better to buy a complete assembly—flex shaft and proper motor—or acquire a sewing-machine or other high-speed universal motor.

Another solution is to buy a special handpiece with a planetary drive which automatically increases the speed at the handpiece to $2\frac{1}{2}$ times the input speed. Thus, for example, if you're driving a shaft at 5,000 r.p.m. with a drill press, you'll get 12,500 r.p.m. at the handpiece. The handpiece can be run as high as 35,000 r.p.m. and can be equipped with collets to take shafts from $\frac{1}{16}$ " to $\frac{1}{4}$ ".

With small flex-shaft machines, you can carve the delicate features of a cameo, engrave plastics, drill hair-size holes—or, as

dentists do, clean out a cavity. And speaking of dentists, ask yours to save his used burrs for you—they will still be suitable for many jobs you do.

How to equip yourself. This depends, of course, on your interests. If you're a welder, or like to clean up dents in auto bodies, or want to apply a satin finish to metals with a wire brush, then you want a big, heavy-duty flex shaft—preferably one driven by its own motor and mounted on our roll-around pedestal (see plan).

If you're interested in jobs such as carving (in wood or metal), engraving, gunsmithing, model building, jewelry making, and polishing, then you should think in terms of the miniature workshop in the tote-about chest. PS



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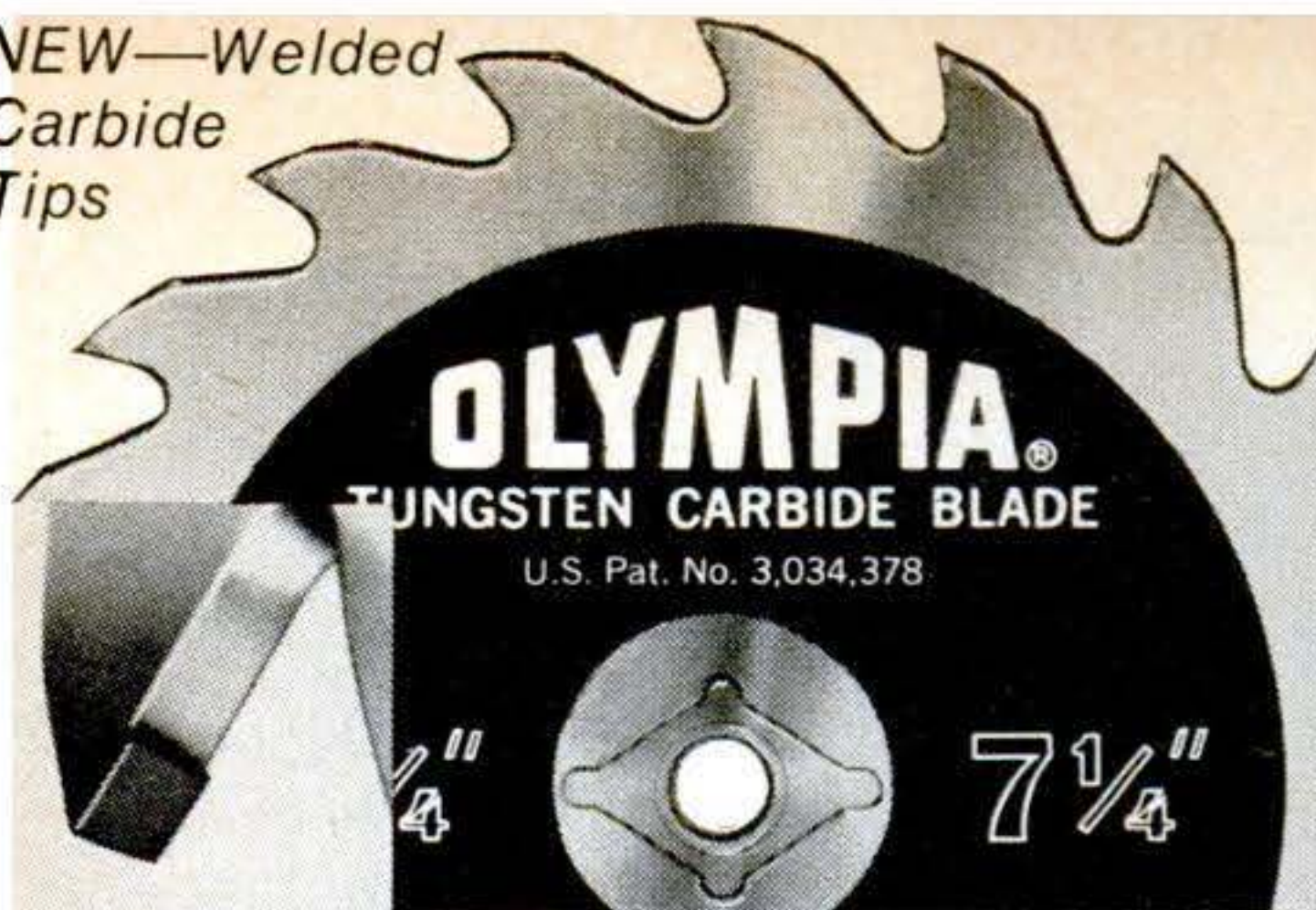
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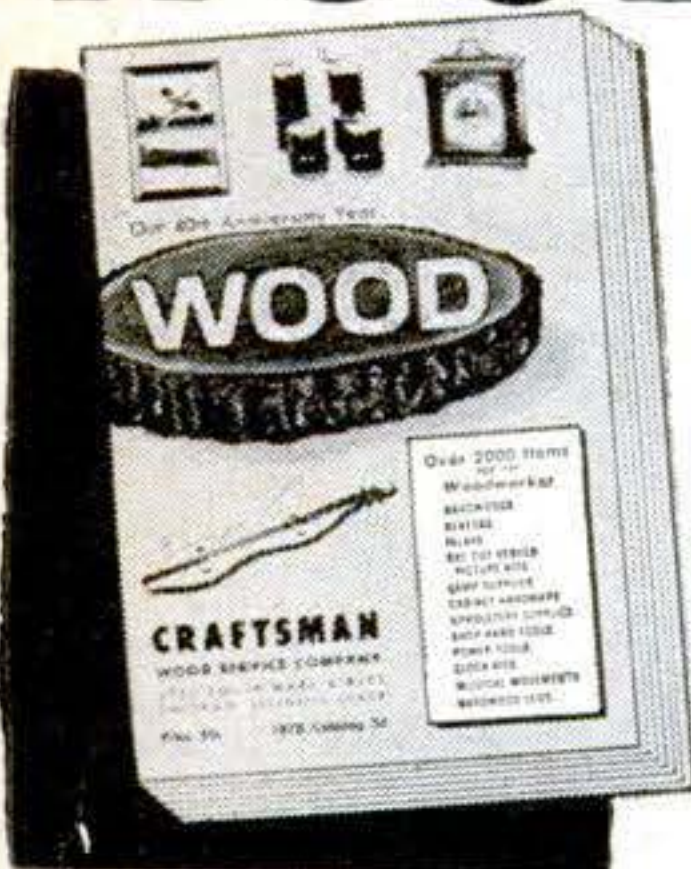
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Tektite Revisited—Under the Waves for 60 Days

[Continued from page 87]

offer the fishwatcher an added dividend. Because it doesn't give off a stream of bubbles, as standard Scuba gear does, he could creep closer to fish and observe them longer without disturbing them.

The Tektite scientists made all kinds of observations and experiments. For example, they sampled the plankton-rich waters at different levels, and examined the rapid turnover and evolution of bottom sediments.

Marine creatures. "When you dive down and swim over the bottom of the bay, you get the impression of an unchanging landscape, like the surface of the moon," remarked geologist Clifton. "Examine it in detail and you find that the floor is literally alive with sea organisms. Marks I made in the sand with my fingers were obliterated in four days—not by any water movement but by these organisms, which tunneled and reworked the top layer."

Much of the bottom sediment is disintegrated coral and shellfish. Studies of sediment formation were made on carefully marked-off grid patterns. Coral reefs are known producers and reservoirs of petroleum, Clifton explained, and the data he and his fellow aquanauts assembled may help provide clues in the search for petroleum and minerals.

Another area of research interest was the habits of marine creatures—important to successful fish-farming and aquaculture. The aquanauts kept a log of all the fishes they saw. There were more than 300 species, ranging from two-inch anchovies to 12-foot sharks. Some individuals were regular visitors. A three-foot barracuda with an identifying notch in his tail set up housekeeping in a narrow space just below the bottom of one habitat tower and was there for the entire two months.

Occasionally, their finny friends played rough. Mahnken told of an encounter with a school of two-dozen big amber-jacks near one of the coral ridges. Each weighed 20 or 30 pounds. "They swam out of the darkness toward us in such tight formation that they looked like one huge fish," he said. Waller added, "I think they were claiming the territory as their own, because they started bumping us in the back and shoulders. Fin-

Tektite Revisited—Under the Waves for 60 Days

ally, we took their gentle hint and left.”

Sharks ahead! As emergency refuges from sharks, five way stations had been set up—cage-like booths with plastic domes, a spare bottle of air, and a phone to call the habitat. As a further safety measure, whenever the men swam out of the habitat—always in pairs—safety divers hovered over them in boats, keeping track of them by the train of bubbles from their breathing gear.

One of the most active research projects was VanDerwalker's pursuit of the spiny lobster, which supplies the local market for lobster tails but whose population has fallen off recently. The aquanauts snared 140, tagged most of them, and to others attached thumb-size sonar transmitters so each one could be tracked as it moved around.

The lobsters are nocturnal, VanDerwalker discovered. At night they would move out to the grass flats where the algae grow and forage for mussels, clams, and immature queen conches. During the day, most holed up in naturally occurring shelters, or “hotels,” like

a certain mushroom-shaped coral. But many lobsters spent the day in large caves 1,000 feet seaward of the Tektite habitat. There they were often preyed upon by nurse sharks.

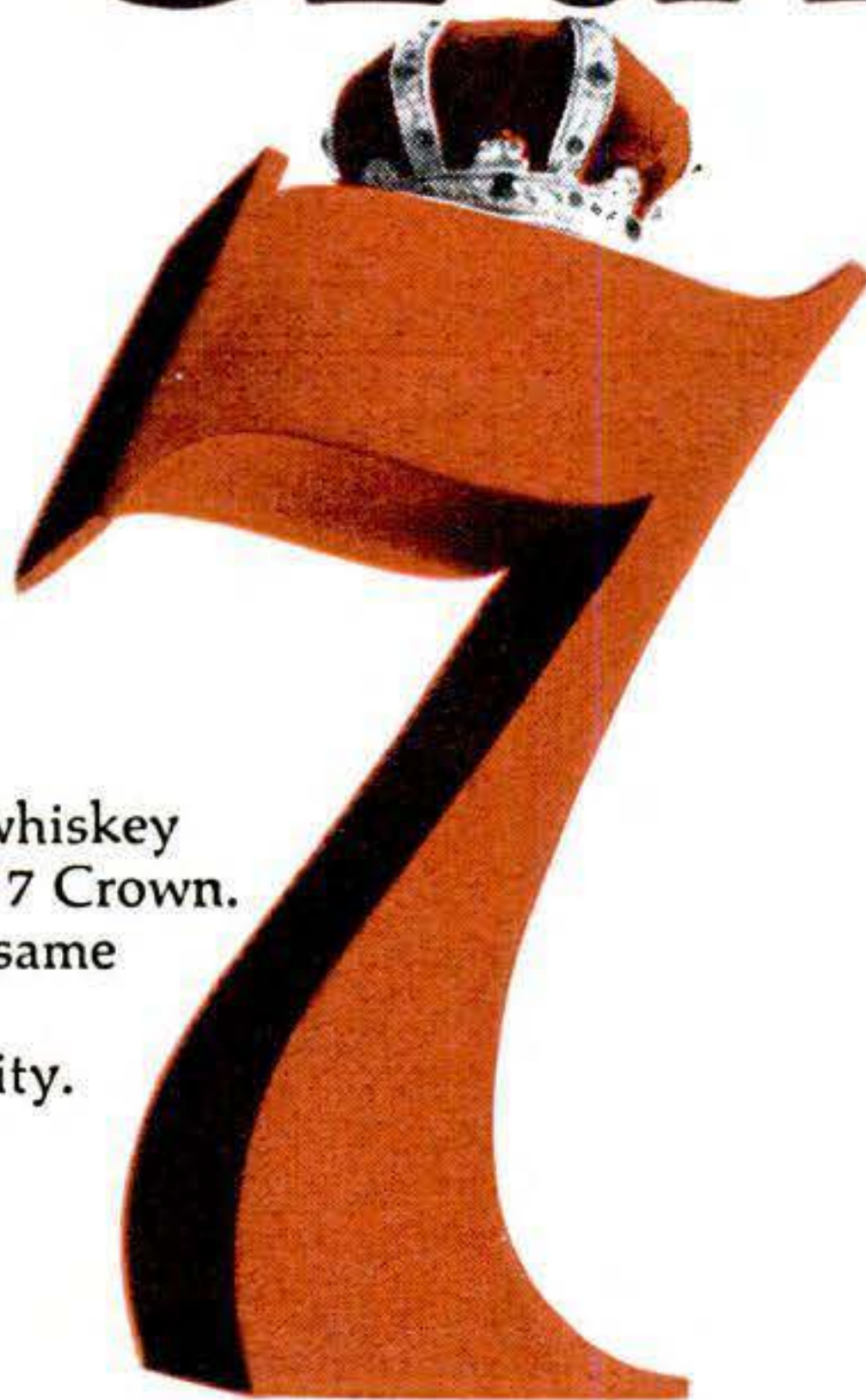
Practical conclusions? “I think the reef could support more lobsters,” VanDerwalker said. “A hatchery could be set up to introduce more young to the area, and perhaps something could be done by using low-frequency sound signals to draw the sharks away from the lobster grounds and dispatch them.”

Another inhabitant of the coral that became a Tektite study object was the curious “cleaner shrimp.” This species, light blue and about an inch and a half long, lives among the dark tentacles of sea anemones. “By flicking their antennae they attract passing fishes,” Mahnken said. “As the fish swim in, the shrimp hop aboard them and begin to pick off their external parasites. They clean the scales, fins, and gills, and even eat away the dead flesh if the fish has a wound.”

The cleaner shrimp is apparently im-

Continued

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Tektite Revisited

mune to the stings of the anemone with which it lives—a fact of interest to the pharmaceutical industry. Perhaps the secret of the shrimp's immunity will lead to chemicals for humans exposed to the many toxic spines and nettles of the sea.

The wet frontier. Underwater exploration is certain to increase in the years ahead. In 1968, federal expenditures for marine research and development were \$432 million. But for fiscal 1969, expenditures have been estimated at \$472 million. The Advisory Commission on Marine Science, Engineering, and Resources emphasizes the need for a greater national "commitment to the sea," and proposes that the United States develop the capability to "occupy the U.S. territorial sea; utilize the U.S. Continental Shelf and slope to depths of 2,000 feet; explore the ocean depths to 20,000 feet."

The depths below 2,000 feet will be explored only from within diving vehicles, built to withstand tremendous pressures. And free diving even at the 600-foot level is still dogged by serious difficulties. (The Navy's Sealab III experiment at that level, off the California coast, was halted at its outset last February when a diver died from carbon dioxide asphyxiation.) The success of the Tektite program, on the other hand, proves the immediate feasibility of broadened exploration of the shallower reaches of the earth's continental shelves.

Today, the little undersea house is back in the Philadelphia Navy Yard, waiting for another assignment. Brendan Thompson, the GE engineer who was in charge of design and construction, says similar habitats could be built less expensively, for missions of shorter duration and with less elaborate behavior monitoring. He believes there is potentially a broad field for their use.

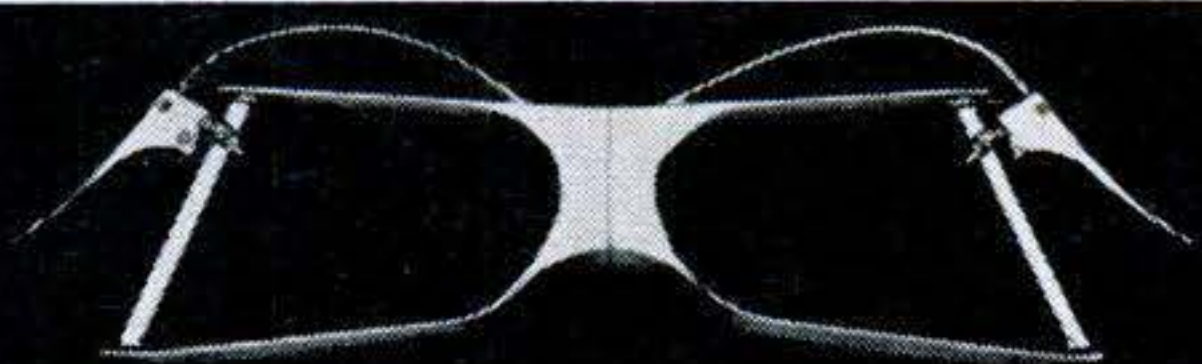
Rick Waller agrees. "Several habitats of the Tektite pattern could be anchored at various locations on the continental shelves. A procession of marine scientists could come and go. Nothing matches the freedom you have in being able to swim around for hours at a time, day after day, without having to go through the long decompression period. For a marine scientist, there is no place like an under-sea home."

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Those Sneaky Little Electric Trollers

[Continued from page 97]

No-hands operation. Those eye-bugging foot-operated remote controls can be had on the Lazi-trol model 150 and heavy-duty 250, on Electra Pal's big Barracuda, on all Minn-Kota models, and on Sears' new model 5926. All give you hands-free steering and on-off motor. The pedal is alive: Depress it, and the motor goes. Roll the ball of your foot over the pedal and three switches underneath turn shaft to left, right, and middle rudder.

Electra Pal's remote gives you 360-degree steering, and adds a small manual control box, just above the pedal, which holds the motor's speed rheostat and an instant-reverse/forward switch.

Minn-Kota's remote runs the motor at whatever speed you have preset on the dial at the head. You reverse by holding the pedal until 180-degree maximum shaft turn is reached, or flick a reverse/forward switch which is optional equipment on this unit. Minn-Kota's remote drive is entirely separate from the shaft, fitting on in halves which are screwed together. List price for this control is \$87.95, and it fits other makes.

Which is the electric for you? It helps a lot to look over manufacturers' catalogs, spec sheets, and price lists. Here are addresses of makers whose products have been mentioned in this article:

Electra Pal Division, Osborn Engineering Corp., 1400 E. Lafayette St., Bloomington, Ill. 61701.

Lazi-trol, Byrd Industries Inc., Ripley, Tenn. 38063.

Minn-Kota Mfg. Co., Inc., Moorhead, Minn. 56560.

My-Te Electric, City Engineering Co., Inc., 3547 Massachusetts Ave., Indianapolis, Ind. 46218.

Rubbermaid Inc., Wooster, Ohio 44641.

Wondertroll Division, Shakespeare Co., Kalamazoo, Mich. 49001.

Sears new Fishing Catalog (to be mailed in January).

Tempo-Troll, Tempo Products Co., 6200 Cochran Rd., Cleveland Ohio 44139.

You'll find valuable information about using your electric troller in "Whisper Fishing," published by Electra Pal, and "More Fish with Silent Fishing," from the Shakespeare Company. Both booklets are free on request.

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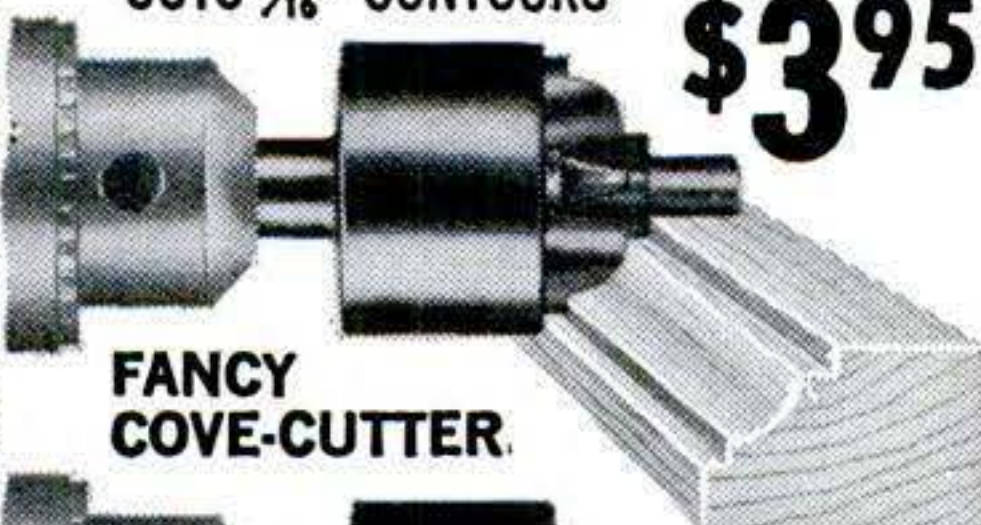
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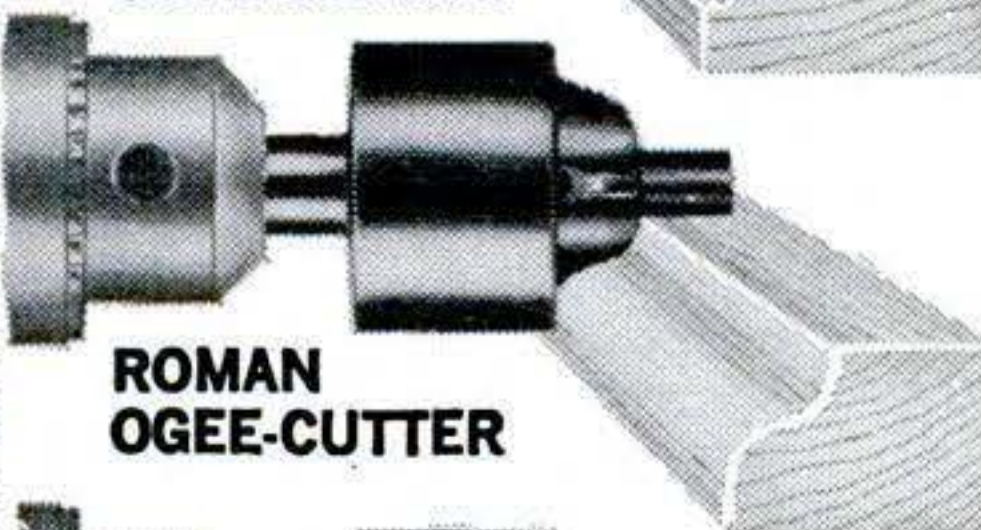
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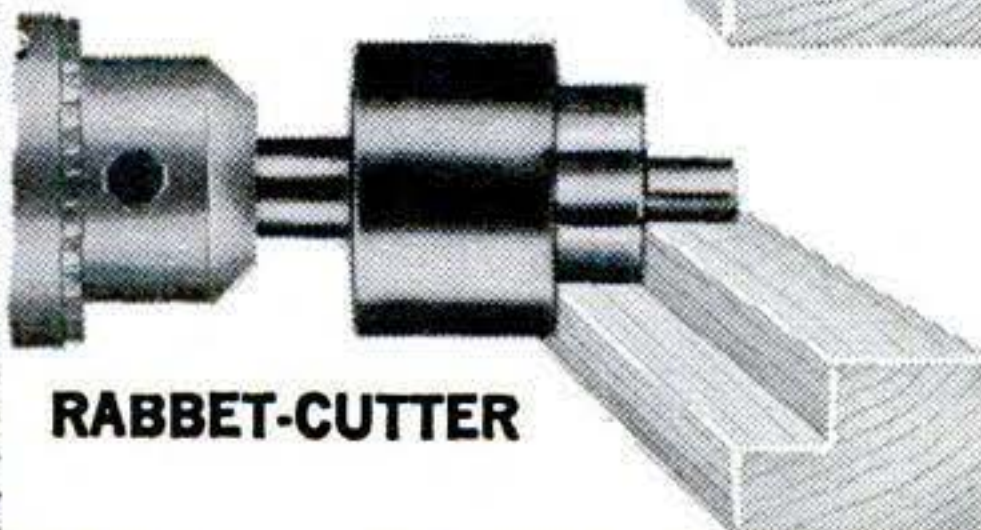
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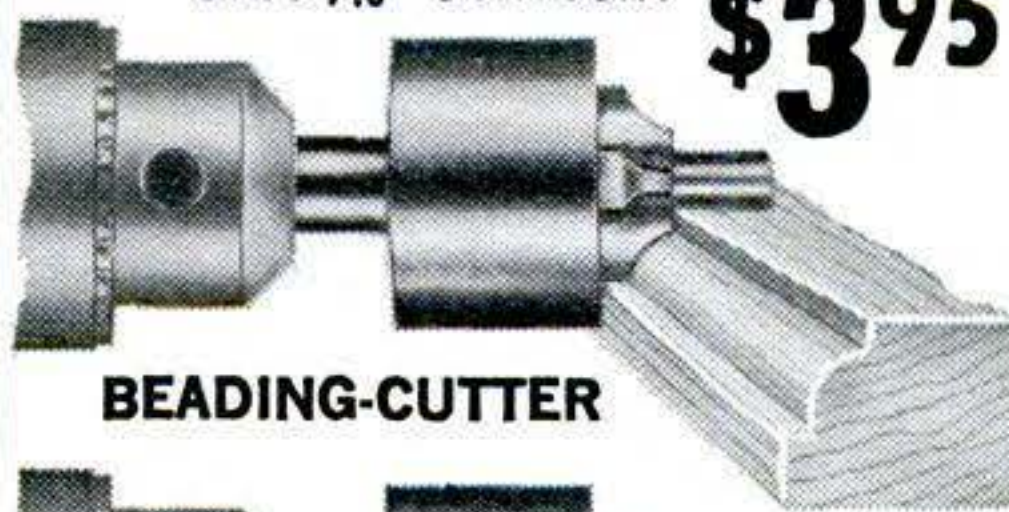
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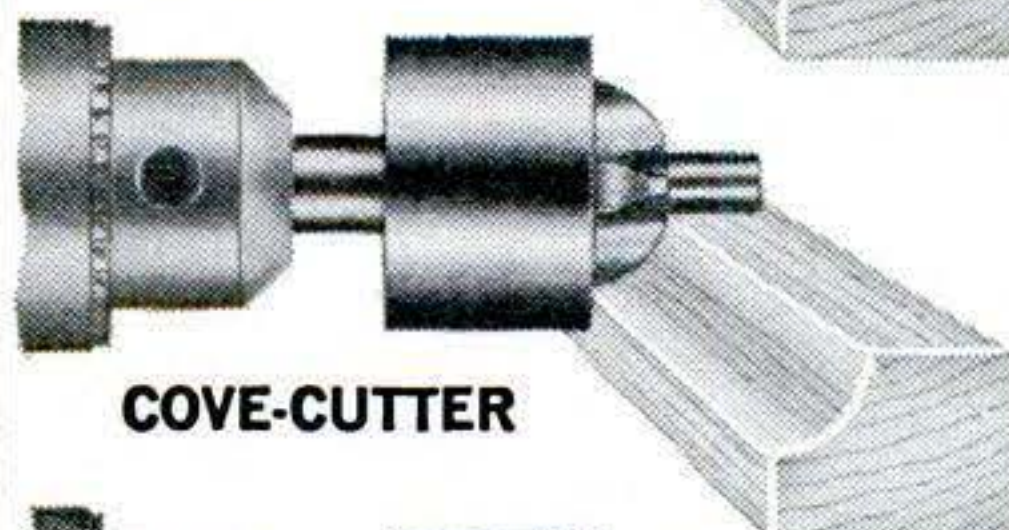
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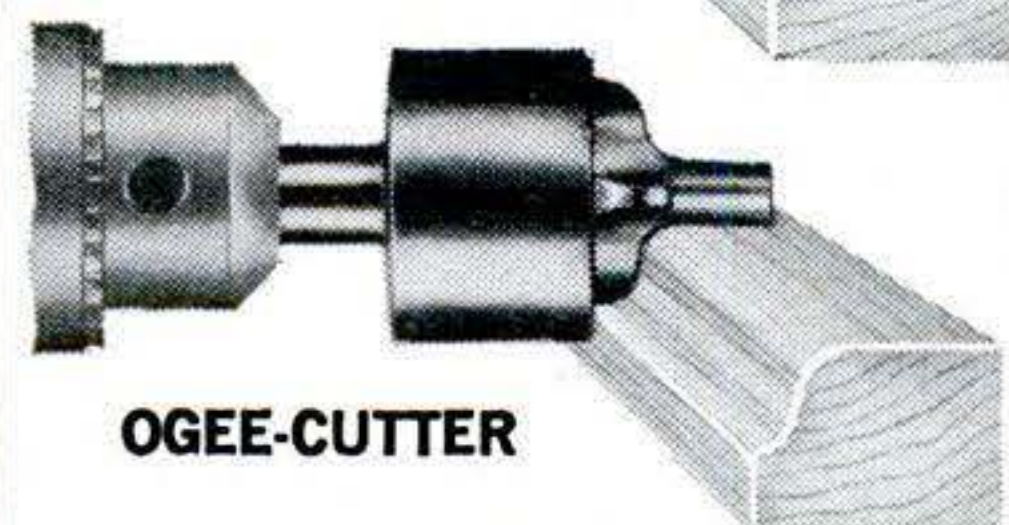
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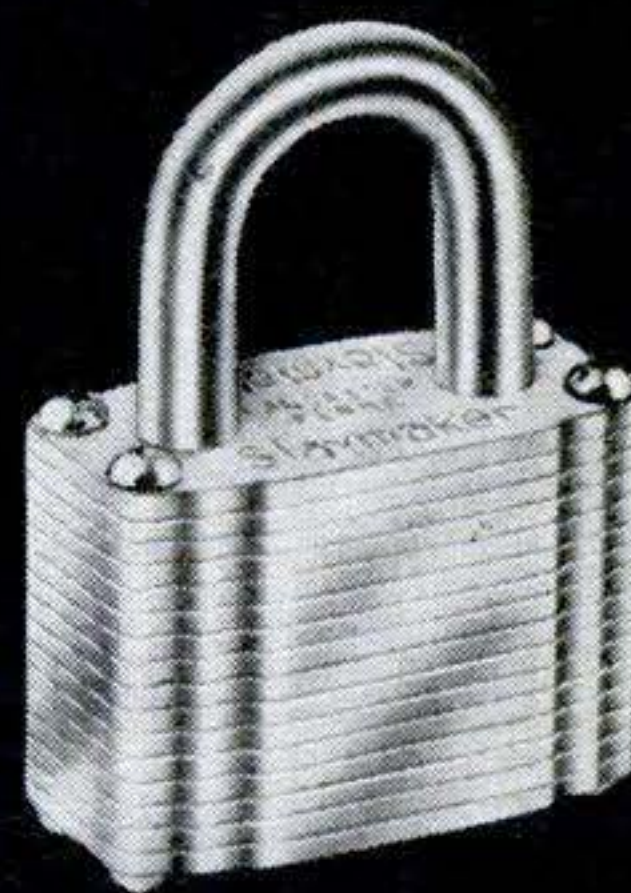
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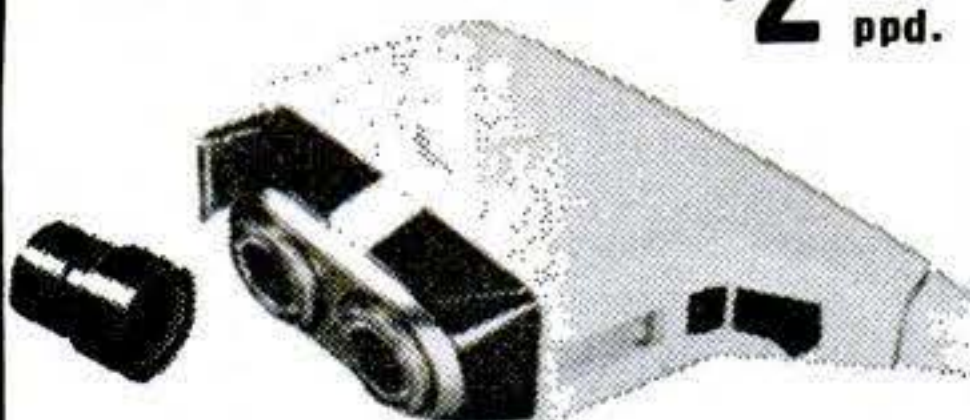
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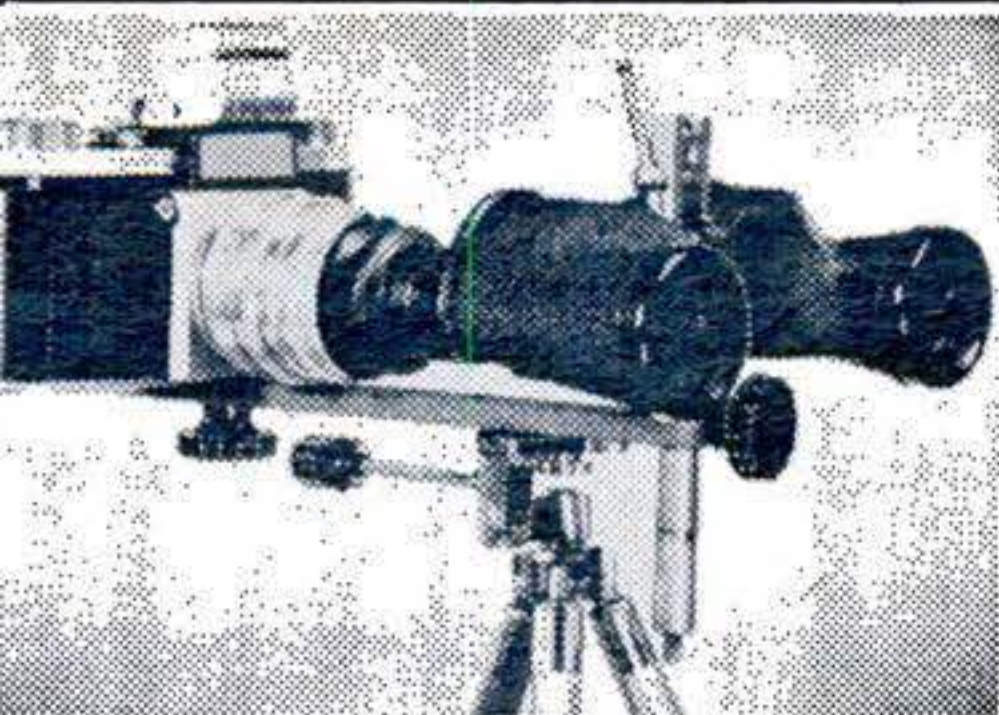
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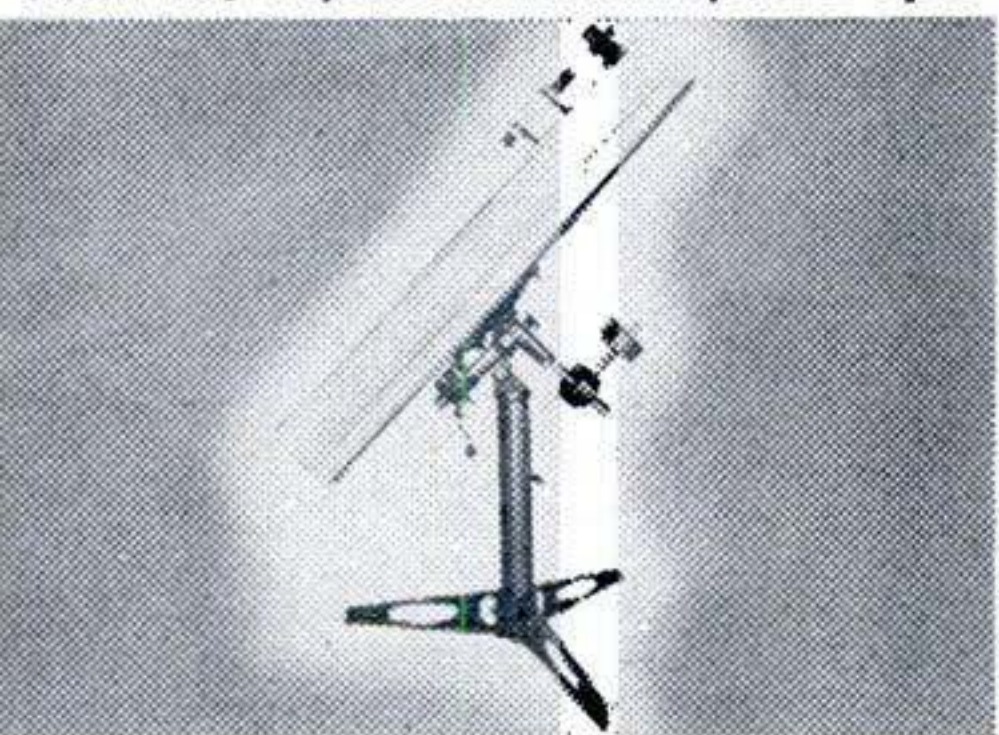
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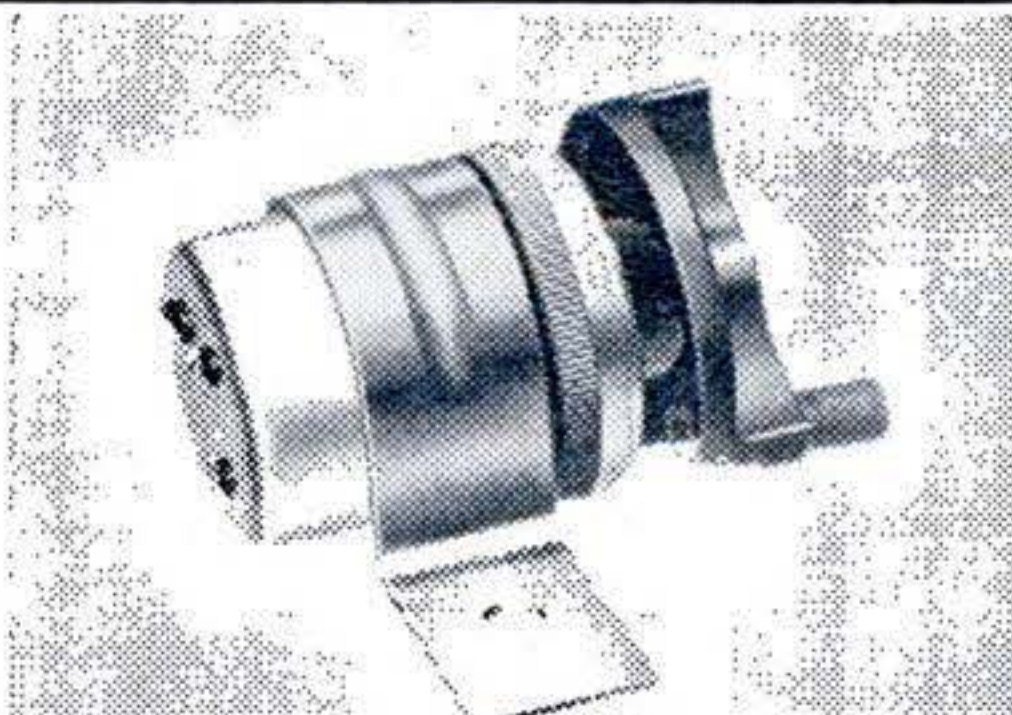
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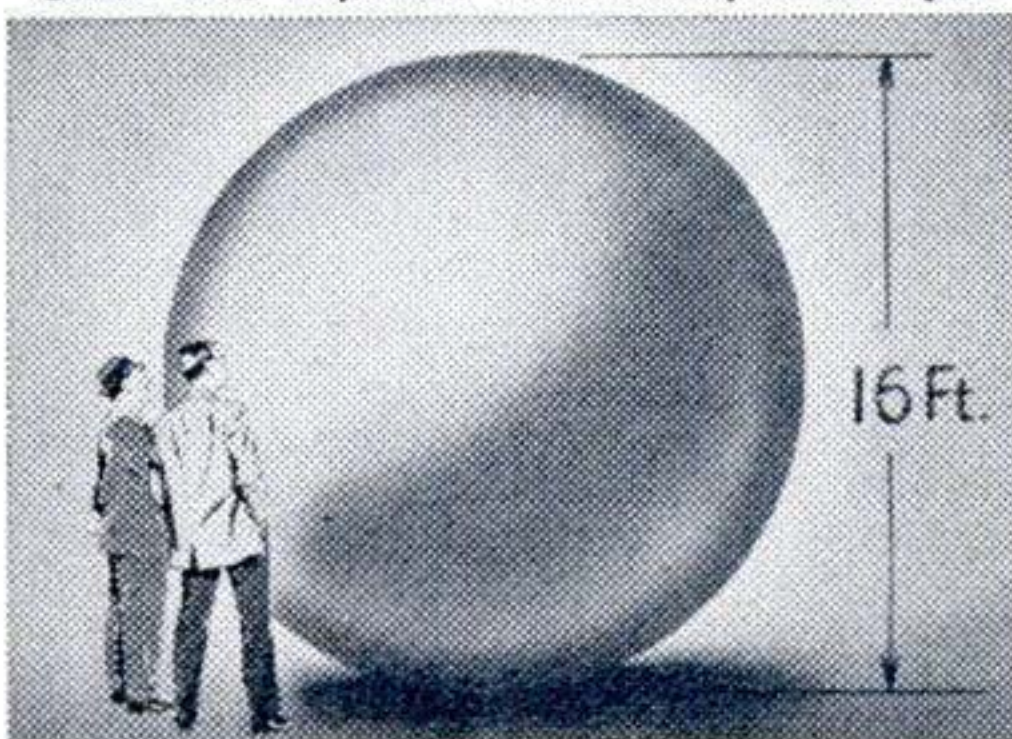
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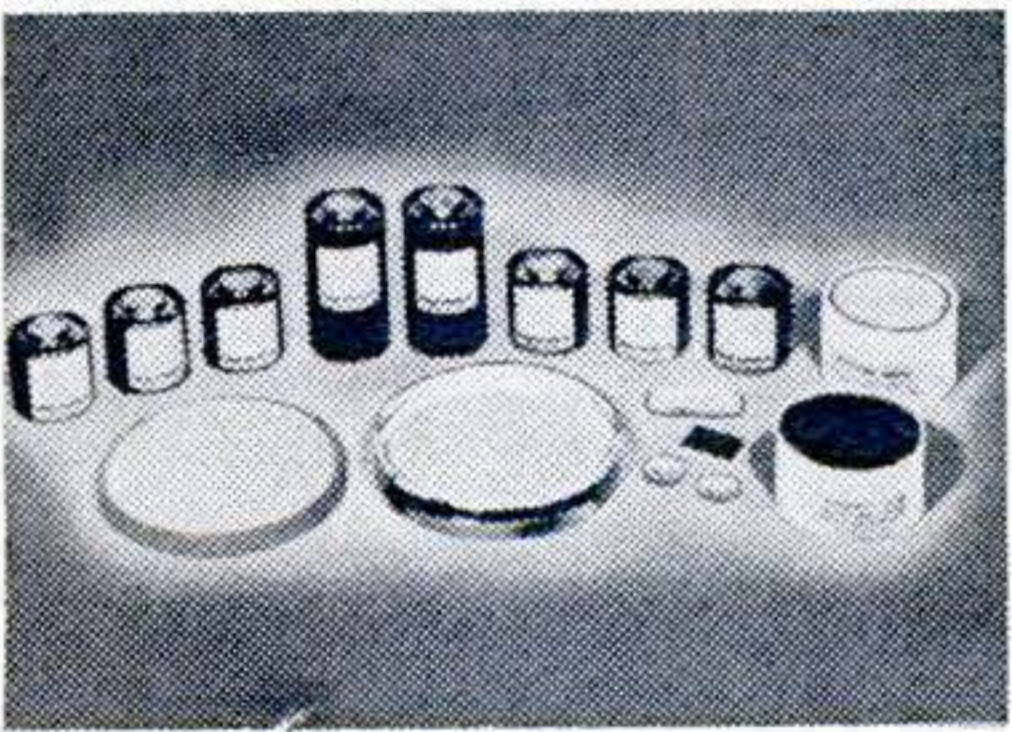
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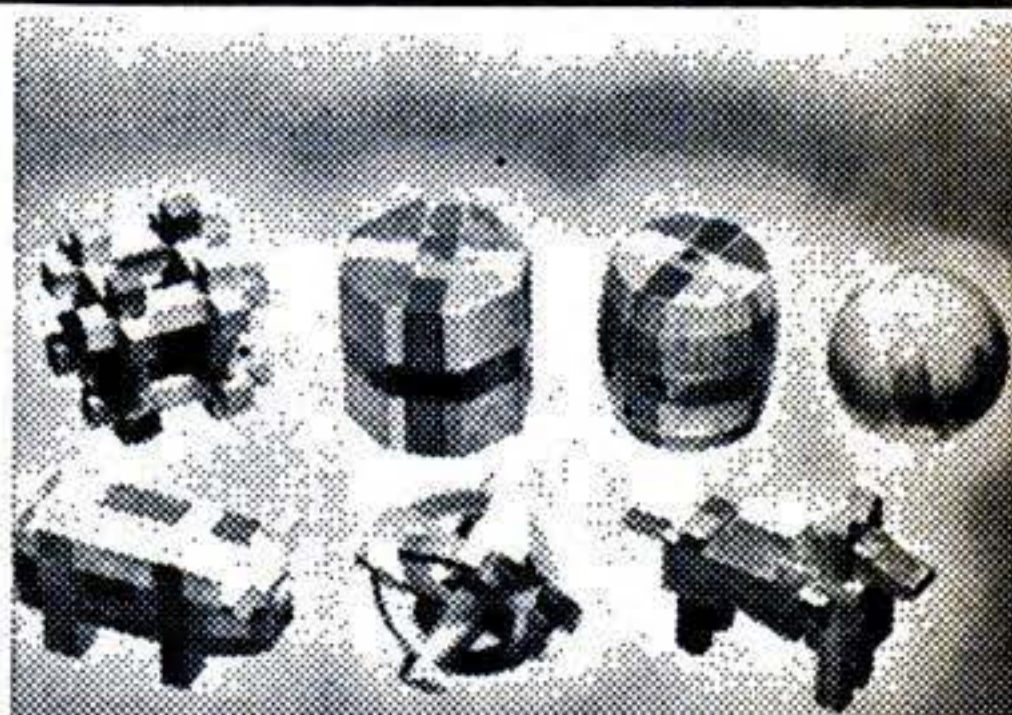
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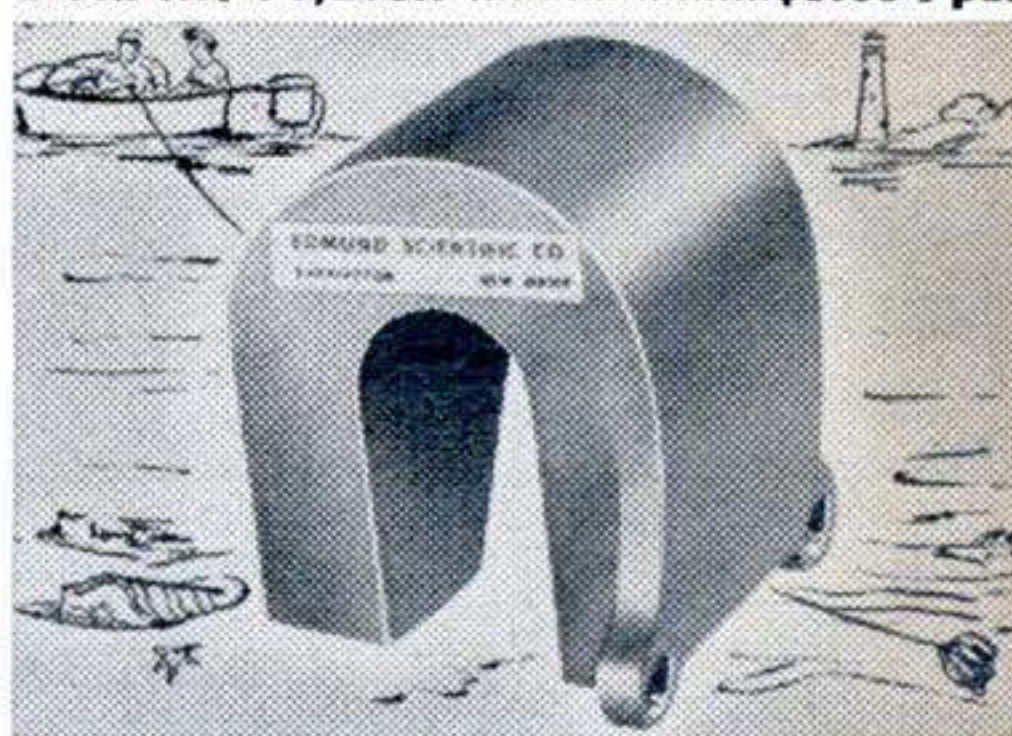
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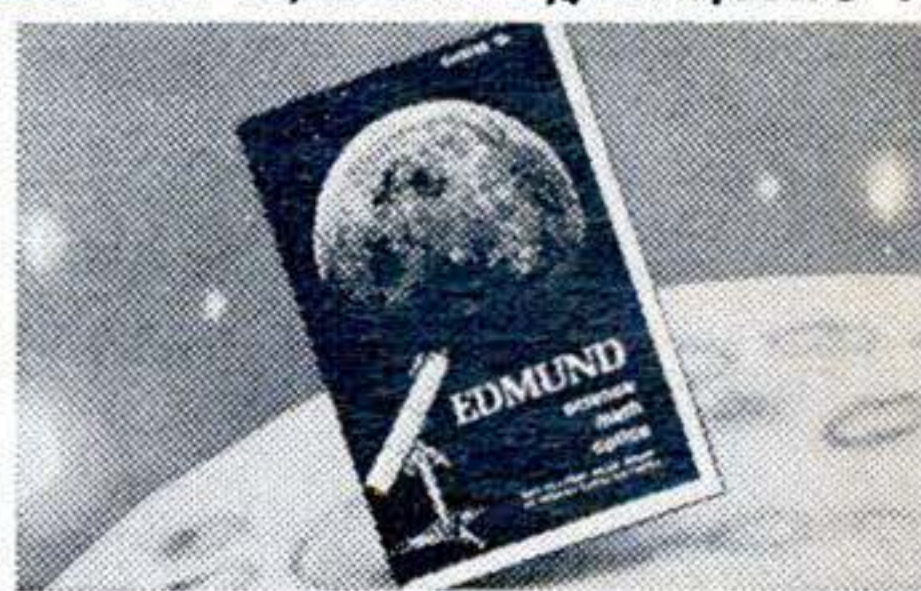
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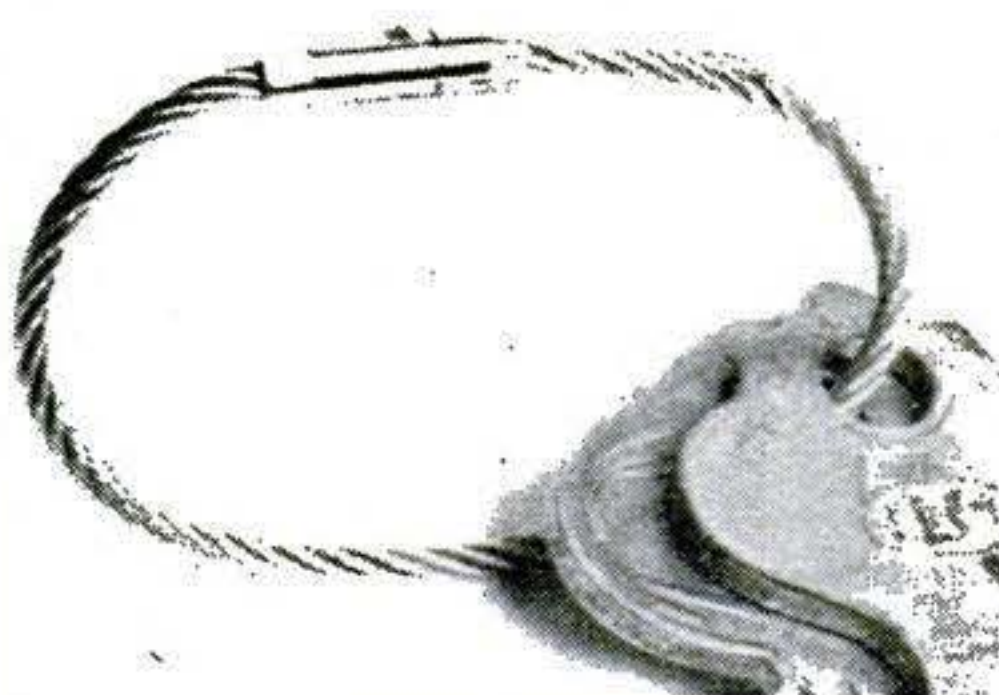
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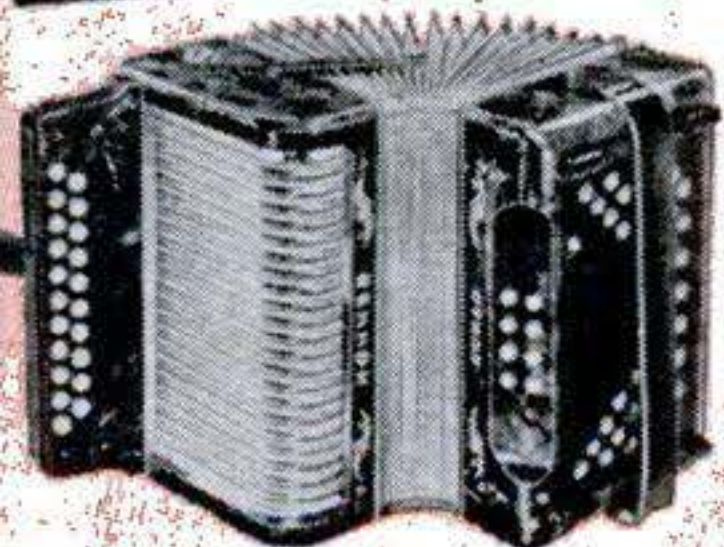
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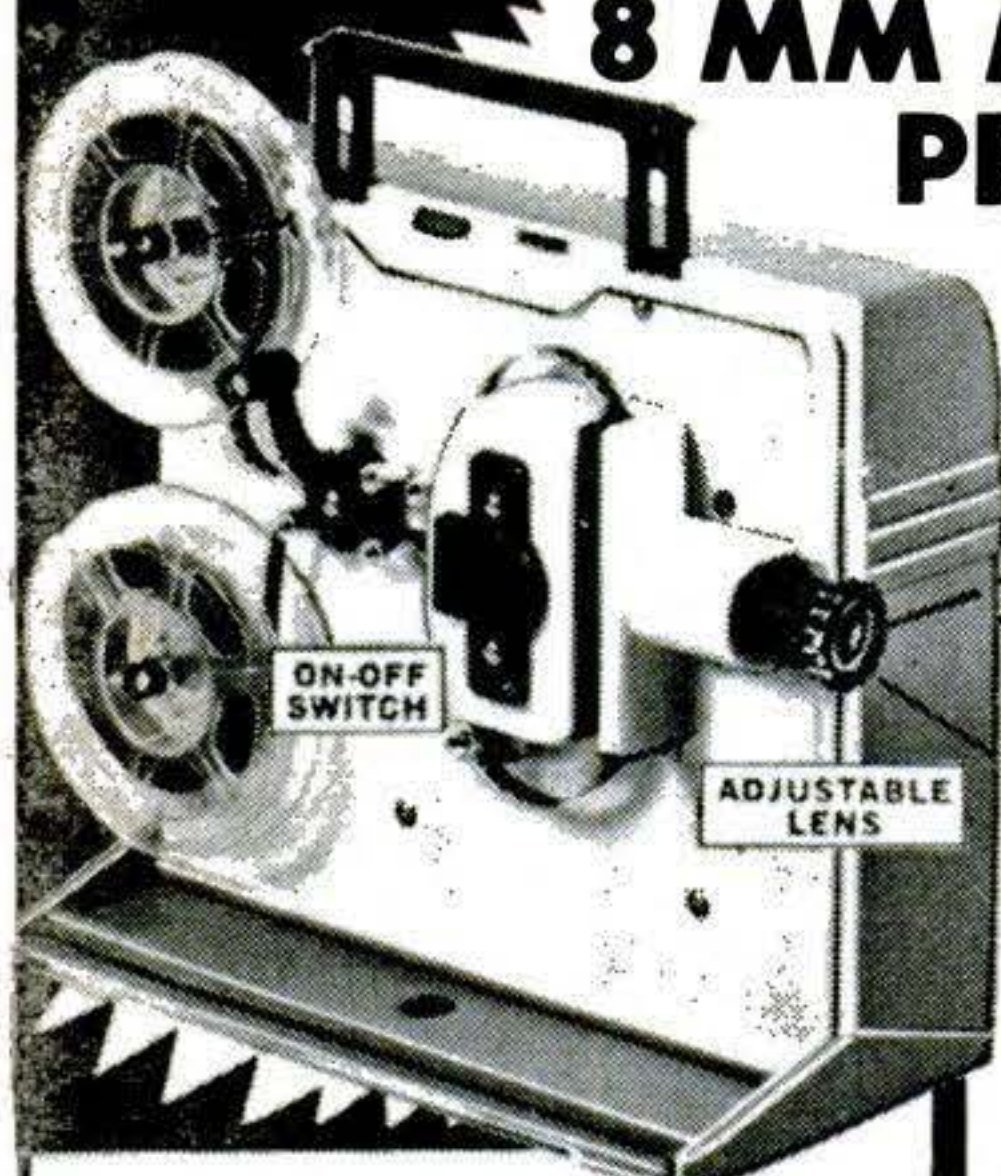
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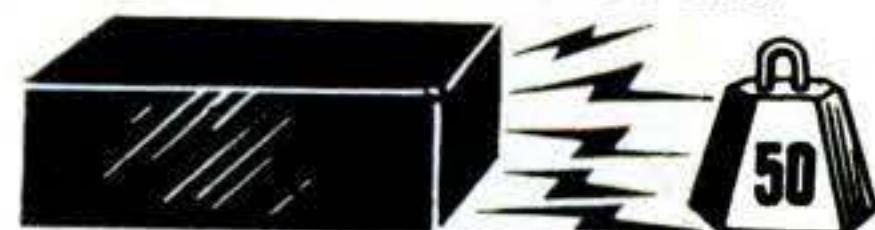
Here is a projector, precision-engineered and sturdily built and so low priced that everyone can now enjoy the thrills of showing home or 8mm commercial movies. And it's so easy to operate. The double lens system and smooth operation give amazing performance. It's so compact, you can take it with you anywhere. (Comes in its own carrying case for easy portability.) No need to hunt for an outlet either—because it has no cord. The batteries (available anywhere) are completely stored in the base and they are ready at the flip of a switch. This quick-focusing automatic Projector shows 8mm color or black-&-white film. If you wish to stop it at a particular frame, you can do so. Speed control lets you speed up film or slow down the action for enjoyment of every detail. (Batteries not included.)

TRY IT FOR 10 DAYS ON OUR MONEY-BACK GUARANTEE! So sure are we that you will be delighted, that we invite you to try it for 10 days and then, if you don't agree that it's a wonderful buy, return it and we'll refund the purchase price—with no questions asked. Don't delay—just send \$6.98 plus 75¢ for shipping & we will rush your projector to you, all charges prepaid. Or order COD by sending \$1 good will deposit and pay postman \$5.98 plus shipping & COD charges when your projector arrives. Same guarantee either way. N.Y. State residents add 5% sales Tax. Additional specs \$2.98 each.

HONOR HOUSE PROD., DEPT. 97NP59, LYNBROOK, NEW YORK 11563

HIGH INTENSITY, LIFETIME BAR MAGNET

Guaranteed to Lift 50 Lbs.

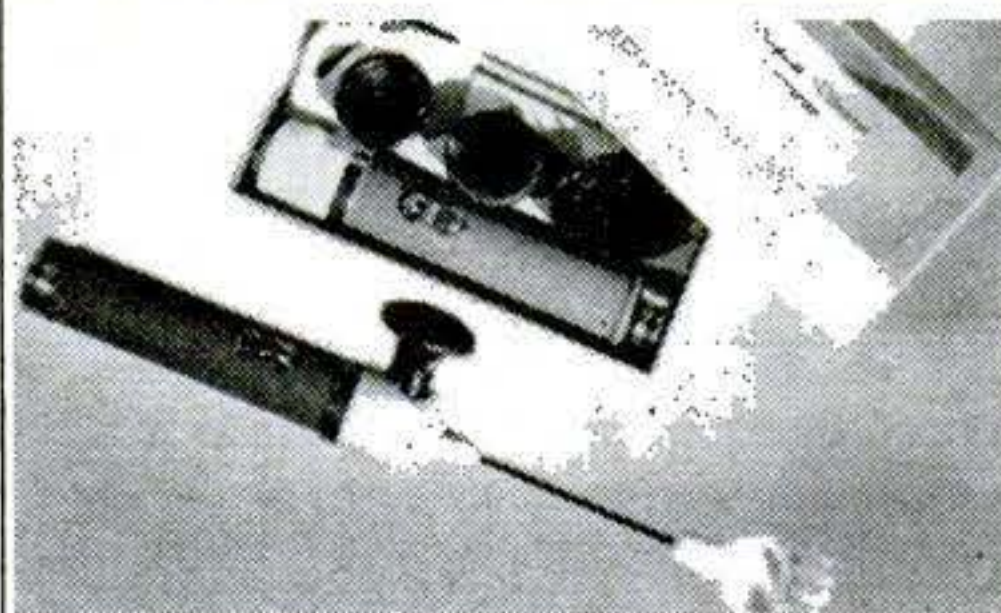


A midget in size, 3" x 3¼" x 1" . . . a giant in strength, holds up to 50 lbs. of iron or steel securely. Has countless uses: tie to a pole and grab those hard-to-reach cans on upper shelves; in the shop it serves as a perfect guide on cutting wood or metal or as a clamp; finds scattered nails and pins; makes an intriguing toy for a child. Practical for home, factory or business, loads of fun.

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PULLS IN 360° CIRCLE, SHARP & CLEAR!
Receives signals over 75 mile radius

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...from Every Direction—over
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OUTPERFORMS COSTLY ROOF ANTENNAS 20 TIMES ITS SIZE!

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You just can't begin to imagine how sharp the pictures and how clear the sound you can receive in your own home, until you've installed this revolutionary new SKYPROBE omni-directional antenna system! SKYPROBE — the result of advanced electronic research — with a uniquely efficient cylinder shape and a superior integrated component system — reaches out to pull in signals over a 360° circle . . . over a radius of up to 75 miles! Color pictures come in snow-free and stable in critical color and contrast! Your TV set and FM receiver work at their fullest potential! You couldn't get better results from a motorized, rotating antenna system selling for 10 times SKYPROBE'S low price! **ONLY \$12.98.**

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Flashes hour, minute, and date in large, clear numbers. Gold or silver-tone case (specify), tarnishproof stainless steel back, satin-brushed dial. Sweep-second hand, black leather strap. Shock-resistant, unbreakable mainspring.

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Removes up to 12 layers of old paint fast... right down to bare wood grain. Leaves surface clean, smooth, ready for recoating. Can be used indoors or out on flat, curved or irregular surfaces. Uses regular house current 110-120 v., AC-DC. Not recommended for varnish, shellac or lacquer.

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216 POPULAR SCIENCE

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9" Overall Length
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- Opens instantly
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Flips open instantly and locks automatically to prevent accidental closing. Razor sharp tough stainless steel blade for reliable use and hard, long service. Money back in 5 days if not satisfied. Send \$2.75 plus 25c to cover postage and handling.

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AFTER
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146 LBS.



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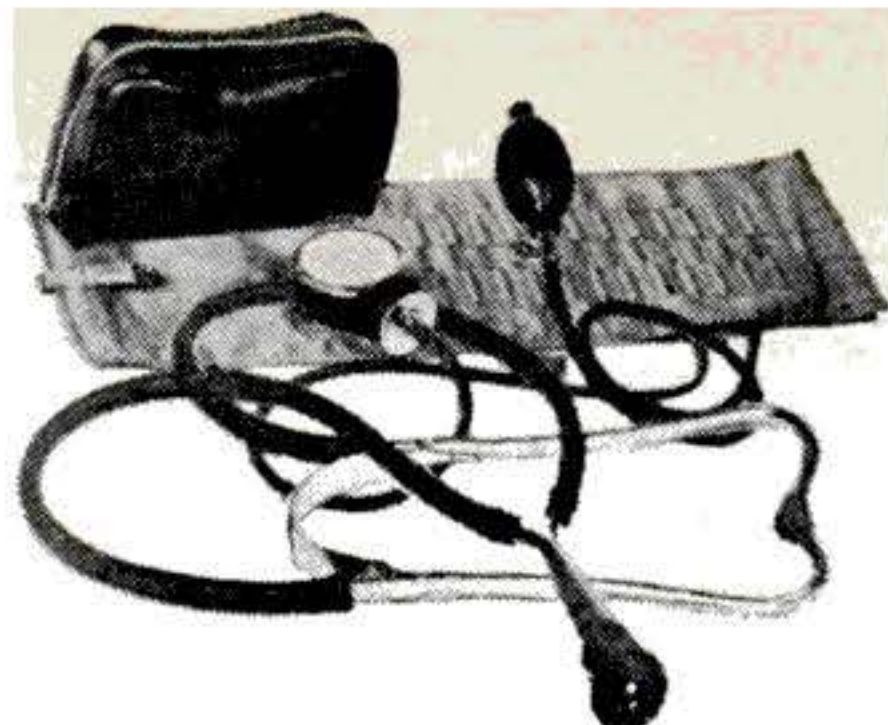
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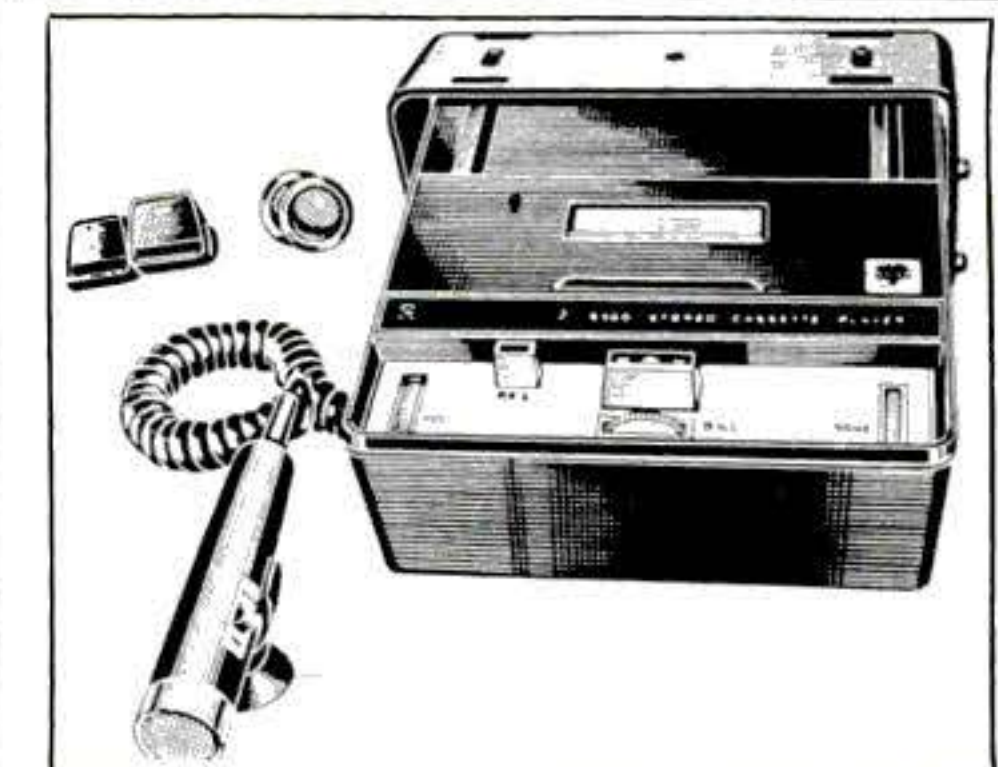
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Ugly Blackheads—Out in Seconds



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Record while you drive. Insert cassette cartridge, press-to-record using dynamic mic. Automatic level control electronically compensates to your 'voice' allowing you to speak at any distance. 12V battery operation for all cars; no flashlight cells to run down. Night light, tone control. Free pre-recorded music tape, extra blank cartridge, microphone. 20-Transistor circuitry. Stereo playback. Instructions. **ALCO**, Box 1348, Lawrence, Mass. 01842. \$99.95.

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New View-Meter model detects objects on the fringe of detectable depths, means more sensitivity.

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If you are over 18 and have the kind of lively mind that loves to solve puzzles, mail this entire ad to us today and we'll send you a new ballpoint pen plus a big copy of our *Puzzle Lovers Newspaper*, both FREE to new inquirers. You'll discover how to cash in on the thousands of dollars awarded every month to our members. They compete for our cash prizes by solving puzzles in the quiet of their own homes. There is no obligation. Send this ad only if you believe you have the talent to solve puzzles and win cash prizes.

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18-7

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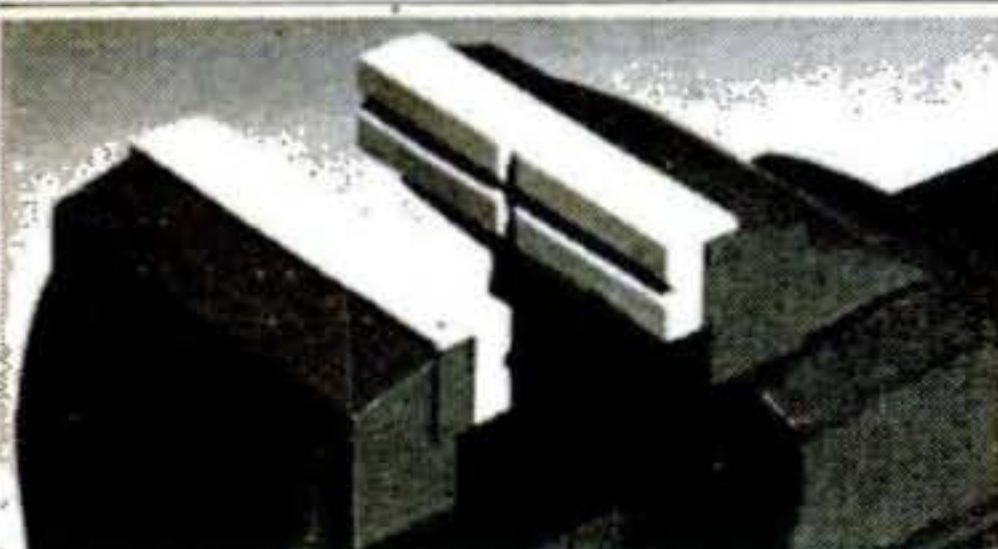
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MAGNETIC VISE JAWS

No. 694-1 No-mar Mag-jaw—4" tough plastic, magnetically adheres to vise jaws. Use for gripping metal work, threaded parts, tubing, delicate instruments, etc. Just send a money order for \$1.95 per pair to Cluthé Sales (Waterloo) Ltd., 141 Weber St., S., Waterloo, Ont., Can. Post Paid. (Ont. residents add 5% tax) Shipments outside Canada or U.S.A. add 15%.

JET CHRONOGRAPH



Tells time, measures distance, registers speed, and serves as a stop watch. Outer revolving ring serves as an elapsed time recorder for parking, sports, conferences, etc. Luminous hands and figures are clearly legible in the dark. Matching Day-Date expansion band. It looks impressive on your wrist or makes an ideal gift on any occasion. Comes direct to you from Switzerland for only \$12.95 ea. Add \$1.— for registered airmail. Send money order, bank check or personal check. No COD's please!

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Half the Length of a Cigarette!
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Latest micro-miniaturization miracle—one of the world's smallest, completely self-contained mike units. Performs with perfect fidelity without wires. Broadcast through blank spot on any FM tuner, table model, portable or car FM and you come thru loud and clear up to 200 ft. away.

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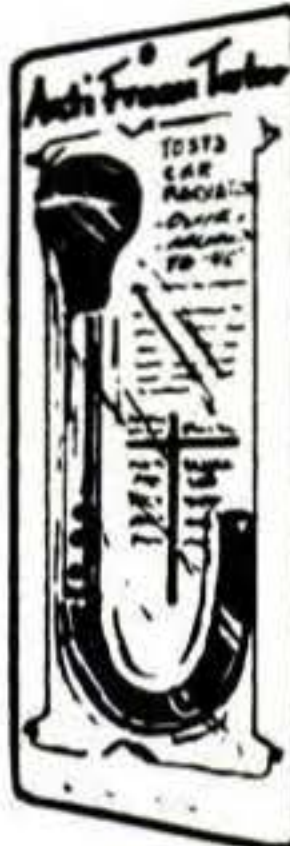
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New electronic circuit guarantees at least TWICE THE DETECTION ABILITY of any detector in this price range or your money back. Find gold, silver, coins, old weapons, etc. Works through earth, beach sand, water, wood, rock, etc. New circuit gives more power, more depth. Not a "probe" type but a fully electronic, 1969 model detector never offered before and available only from VIKING. Only detector in this price range sold on unconditional MONEY BACK GUARANTEE! You must



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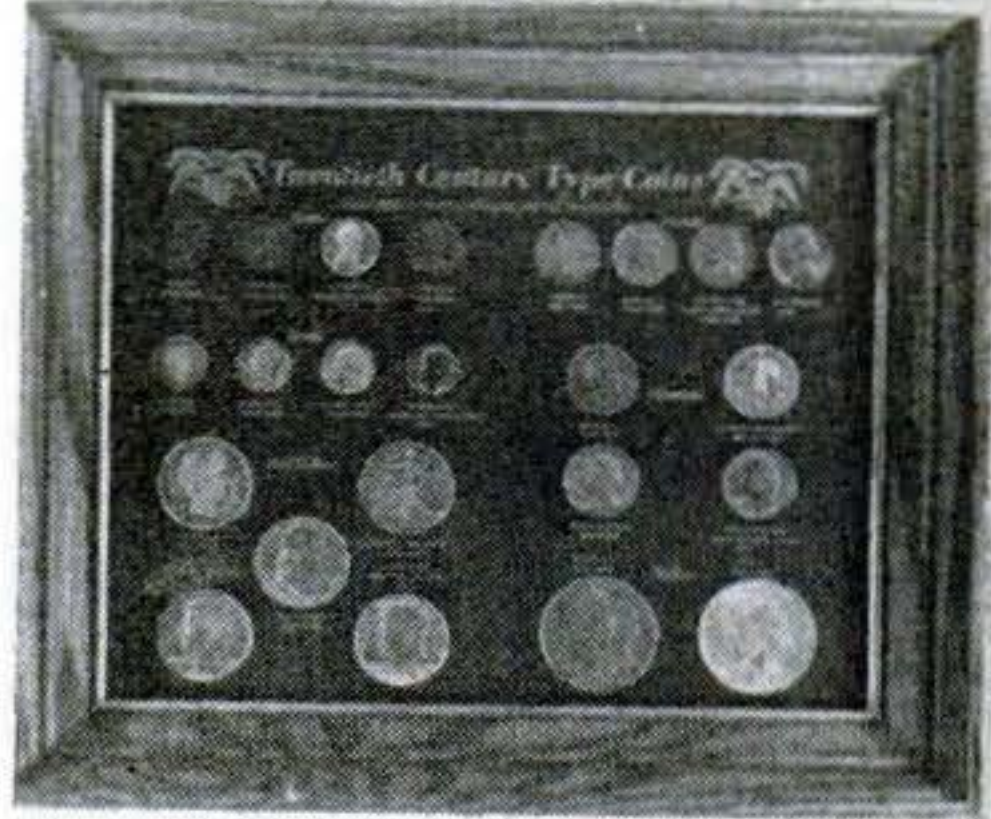
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Deluxe 20th Century Set—One coin of each type minted from 1864 Indian Cent series through 1968 J.F.K. bi-metal 1/2 dollar plus scarce 1964 Silver 1/2. A total of TWENTY-THREE different coins arranged by series. Included are one Peace Dollar and one Morgan dollar over 80 yrs. old in uncirculated condition plus 10 other asstd. collectors coins in new mint condition. Set is mounted under crystal clear protective lucite beautifully displayed in 10 x 12 walnut finished frame with gold trim. Easel back, will stand or hang as decorative work of art for home or office. A sound investment, educational gift or conversation piece which will increase in value. Order now supply limited. Priced at a low \$29.50. Sold on money back guarantee. Send \$5.00 deposit on C.O.D. orders. Not available in stores. Write for free catalog. Novel Numismatics 31-2nd Ave., Dept. A28, N.Y., N.Y. 10003.

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How to get rich

How can you get rich some day? Make a hit record . . . a killing on the stock market . . . or invent a gadget like the hula hoop?

For most of us, these are just dreams. But have you ever stopped to think that there *is* a way to get rich—possibly only one sure way? Most fortunes, as you know, are made by people who own their own business.

Perhaps you've thought of starting a small business of your own . . . a franchised drive-in, or maybe a service business. Trouble is, you need \$10,000 to \$15,000 to get started and even then it's a gamble—with slim chance of ever making really big money.

But there is *one* business which could make you rich—almost overnight. And the beauty of it is, you can start on a shoestring during your spare time, even while holding your regular job.

Cash by Mail

The business is Mail Order—and it's fabulous! Come up with a 'hot' new item . . . and WHAM!

It strikes like a bolt of lightning! Suddenly, you are deluged with cash orders from all over the country . . . MORE MONEY than you could ever make in a lifetime!

Like the Vermont dealer who ran one ad in Sports Afield Magazine. His ad pulled 22,000 orders—over A HALF MILLION DOLLARS IN CASH!

There is no other business where you can make a fortune so quickly!

• A beginner from Newark, N.J. ran his first small ad in House Beautiful—offering an auto clothes rack. Business Week reported that his ad brought in \$5,000 in orders. By the end of his first year in Mail Order, he had grossed over \$100,000!

• Another beginner—a lawyer from the midwest, sold an idea by mail to fishermen. Specialty Salesman Magazine reveals, "he made \$70,000 the first three months!"

Proof

It's a fascinating business! Running ads in newspapers and magazines . . . mailing gift catalogs . . . getting cash orders in your daily mail—steady as clockwork.

There is no other business where you can start on a shoestring and pyramid your profits—*without investing in merchandise!* One husband and wife mail order team took in \$40,000 selling one item. They obtained FREE ads in national magazines . . . didn't invest a cent in merchandise, and even got the supplier to ship all orders for them!

These exceptional cases are absolute proof that *you can get rich* in your own Mail Order business. Very rich.

Even a U.S. Gov. Report stated: "A number of one-man Mail Order enterprises make up to \$50,000!"

Pick up any magazine. Notice how the same mail order ads are repeated . . . month after month? That's concrete proof! You know those ads wouldn't be repeated over and over again—*unless* they were bringing in big cash profits to their owners.

The Secret

The secret of getting rich in Mail Order lies in *financial leverage*. It's a little-known, almost secret method—using other people's capital to make money for you!

You can get thousands of dollars worth of advertising in big national magazines—without investing your own money! And you don't have to write a single ad. Tested and proven ads are prepared for you by experts. Reinvest the profits from your first successful ad—to get more, larger ads, and the profits begin to snowball! It's like building a chain of stores . . . each new store puts more money in *your* pocket.

You mail out beautiful catalogs which offer hundreds of dollars worth of fine, quality gifts—yet you don't

ing catalogs, could bring you a steady income for the rest of your life!

Yes, Mail Order is the fastest-growing, most profitable business in America! And now, with more people moving to the suburbs . . . the population explosion . . . and the expanding teenage market . . . we are on the verge of the BIGGEST BOOM in Mail Order history!

Now, with the help and backing of Mail Order Associates, Inc., of Montvale, N.J., you can follow the same proven steps to Mail Order success—using the 'secret' of financial leverage!

Start Now

We supply you with beautiful gift catalogs throughout the year. All products are drop-shipped for you, with up to 100% mark-up! You get free samples of top-selling mail order items, plus monthly trade reports on 'hot' new products . . . tested, successful ads are sent to you monthly. You get advertising directories, postal laws, complete courses, expert guidance—**EVERYTHING** you need to practically guarantee YOUR SUCCESS. Why? Because *our* business depends upon *your* success. It's mutually profitable!

A recent feature article in Income Opportunities Magazine stated, "Mail Order Associates Inc., offers the most comprehensive Mail Order program ever offered to beginners." They go on to say, "This could be the opportunity you've been looking for. A chance to get in on the ground floor in a little known business which we believe is on the verge of a new boom."

Free

We are now accepting a limited number of charter members in our new Mail Order Program. No previous experience is required but you must be over 21.

If you are sincerely interested in starting a profitable business on your own . . . if you can see the tremendous advantages which Mail Order offers . . . then ACT NOW!

Mail the coupon today, or simply send your name and address on a postcard. No salesman will call. We will send you a free book—gift catalog, reprints of feature articles, plus complete facts about our program. Write to:

Mail Order Associates, Inc., Dept. 203
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The thrill of receiving money in your mail is one you'll never tire of!

invest one cent of *your* own money in merchandise! Your catalogs are printed with your name and address, so all orders come to you. Everything is "drop-shipped" for you, and there's up to 100% mark-up! You pocket the cash profits immediately—even before the orders are shipped to your customers!

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**Rush Coupon for
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plus reprints of
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articles

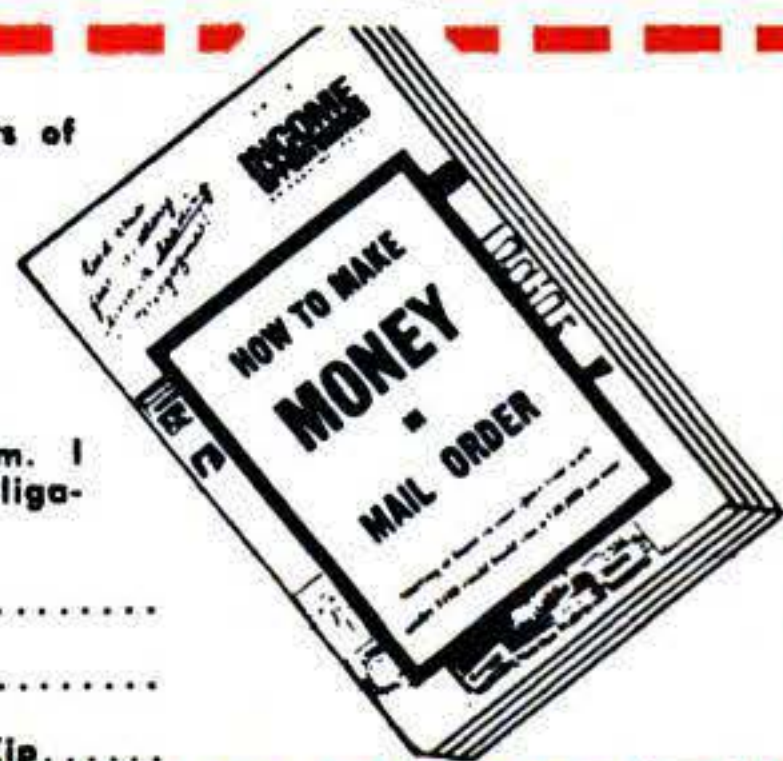
Mail Order Associates, Inc., Dept. 203
Montvale, New Jersey 07645

Please rush complete details on your Mail Order Program. I understand everything is free and there is absolutely no obligation. I am over 21.

Name

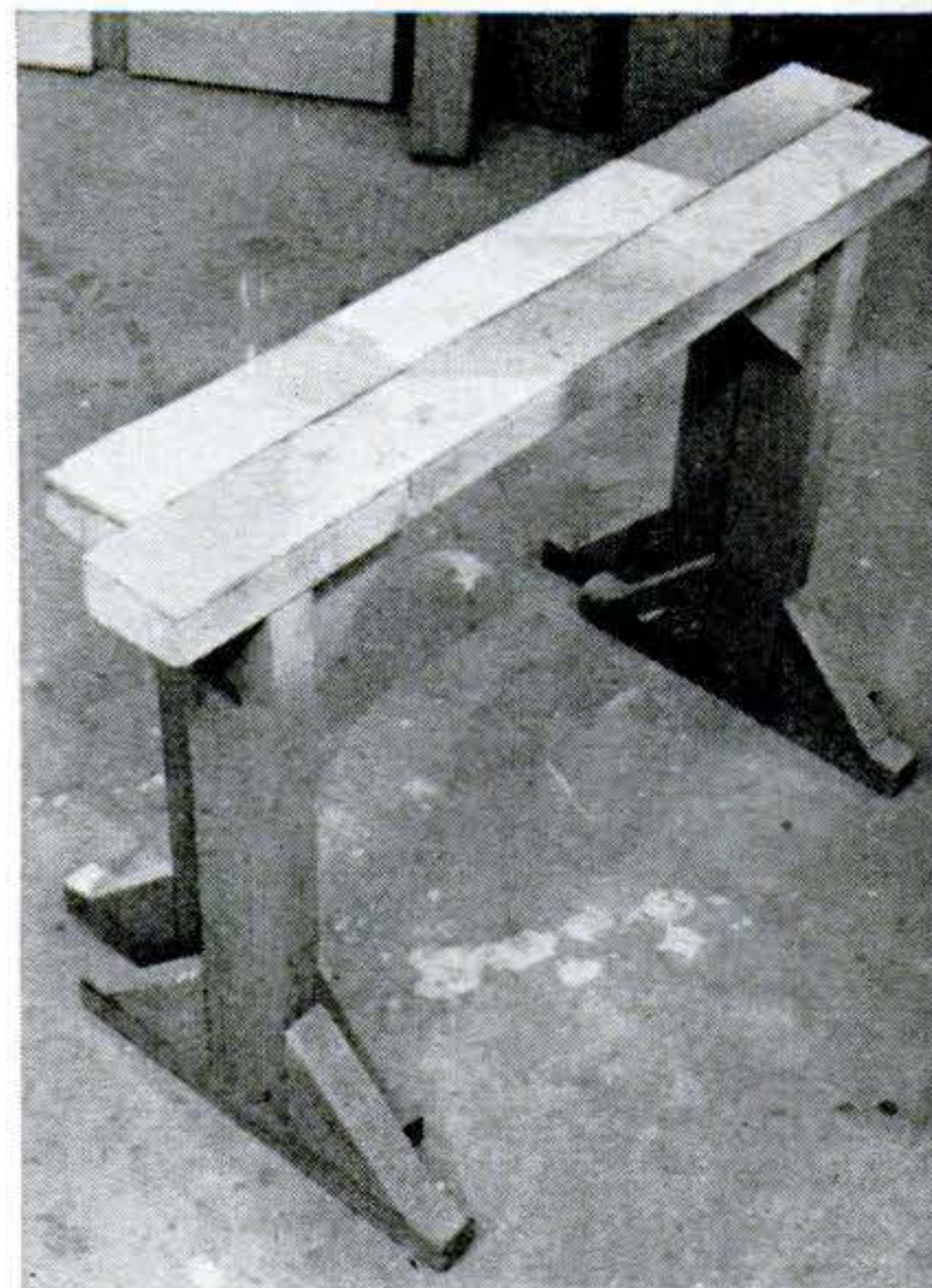
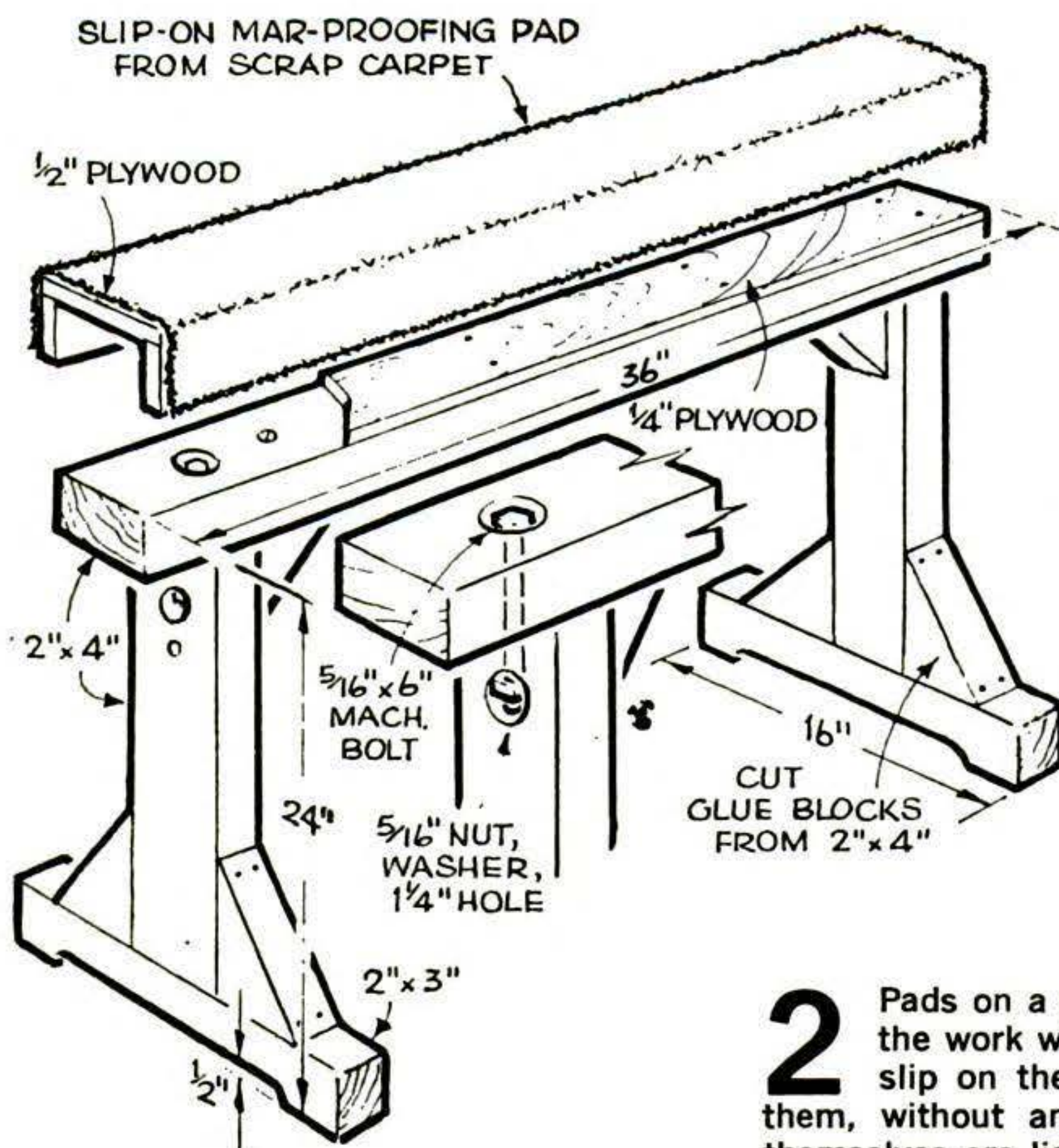
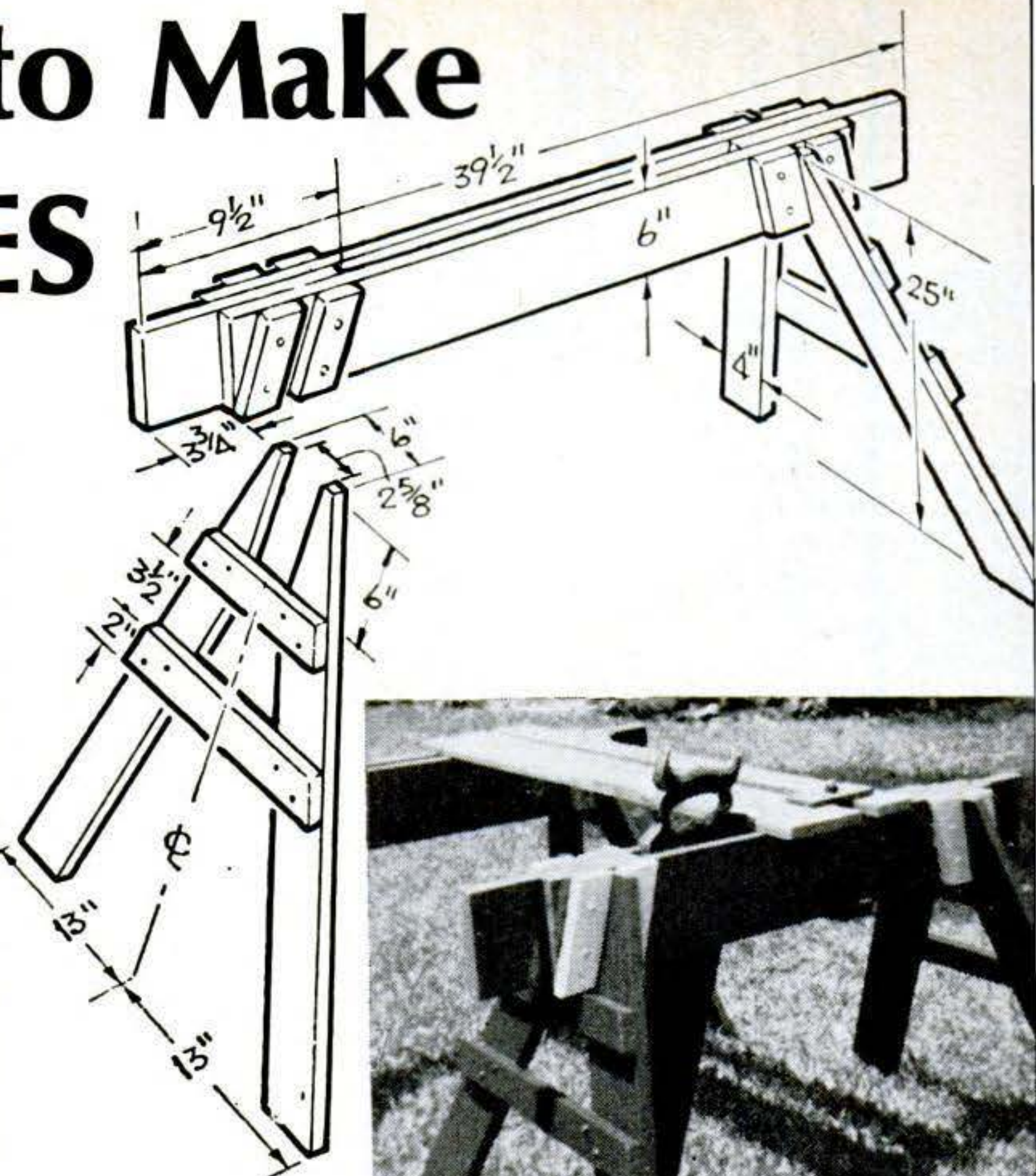
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City State Zip



Two Ways to Make SAWHORSES

1 Take-apart sawhorses of this type are used by many police departments as street barricades. They're equally as useful around a home, for the parts take up much less space than the whole. The slotted horizontal member does more than support work. As you can see in the photo, a handsaw can be stored there between cuts. Also you can use long bolts and wood cleats to fasten work-supporting boards across a pair of the horses. The horses shown in the illustrations have one-by-six horizontal members. A short piece of one-by-six at each end is sandwiched between longer pieces, providing the useful slot. Total length of the horses is 39½". You can shape legs from one-by-sixes or perhaps one-by-fours. Use one-by-twos to form guide slots for legs and for cross braces on legs. For the strongest assembly, use screws and small bolts to fasten the parts.



2 Pads on a pair of sawhorses are a good idea to protect the work while you are applying a fine finish. The pads slip on these T-shaped horses snugly when you need them, without any special attaching hardware. The horses themselves are lighter and store in much less space than the conventional angle-legged type. You can also place them side by side as seen above to provide a wider work surface when this is needed. Glue blocks give rigidity to the assembly. To keep the joints tight, the leg-attachment bolts can be snugged when you replace the expendable plywood wearing surface.

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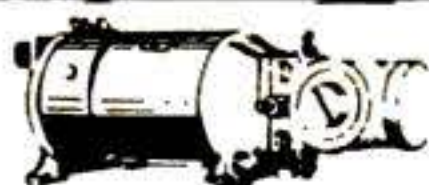
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224 | POPULAR SCIENCE

Just for Fun—Take a Minibike Along

[Continued from page 100]

A handlebar lever, incidentally, is more convenient for applying a minibike's brakes than a pedal.

Tires. Increasingly, minibike makers are putting on tires with rounded instead of square edges. The rounded ones steer better.

Suspension. Examine the suspension, if you want one. Except on the miniature motorcycles, most front suspensions are telescoping tubes that have little effect. Whether yours has one, therefore, probably makes little difference.

Rear suspensions, however, have come a long way. Some are still toy-like, but many are now as robust as those used on motorcycles. You'll appreciate a hefty hydraulic shock absorber under you, cushioning the bumps.

Engine. This is the vital heart of the little beast. If you already know something about the maker's reputation in lawn-mower, pump, compressor, or chain-saw engines, you're a step ahead of the game. If not, ask around among minibike owners. Tinkering with a hand-started engine is just as frustrating with a minibike as with a lawn mower.

In general, miniature motorcycle engines—having been designed for vehicle use—are less likely to give trouble. They also have kick starters, which are easier to operate than pull cords. Of course, they cost more.

Try them out. Most dealers won't let you test ride a new minibike. One reason is that the first time you fire it up heat blisters the paint off the small exhaust outlet—which makes the bike look like a used one.

You'll just have to ask acquaintances to let you try theirs—you can learn to ride in a few minutes. This will let you judge the machine's balance—doing a wheelie is only fun when you're expecting it. You can hear the exhaust note and decide whether a full-size muffler would be preferable. And you can experience the power, suspension, and brakes for yourself.

It's worth considerable effort to narrow down a field that has become as crowded as the minibike market. The breed has much to recommend it; you may as well have all the fun you can. **PS**

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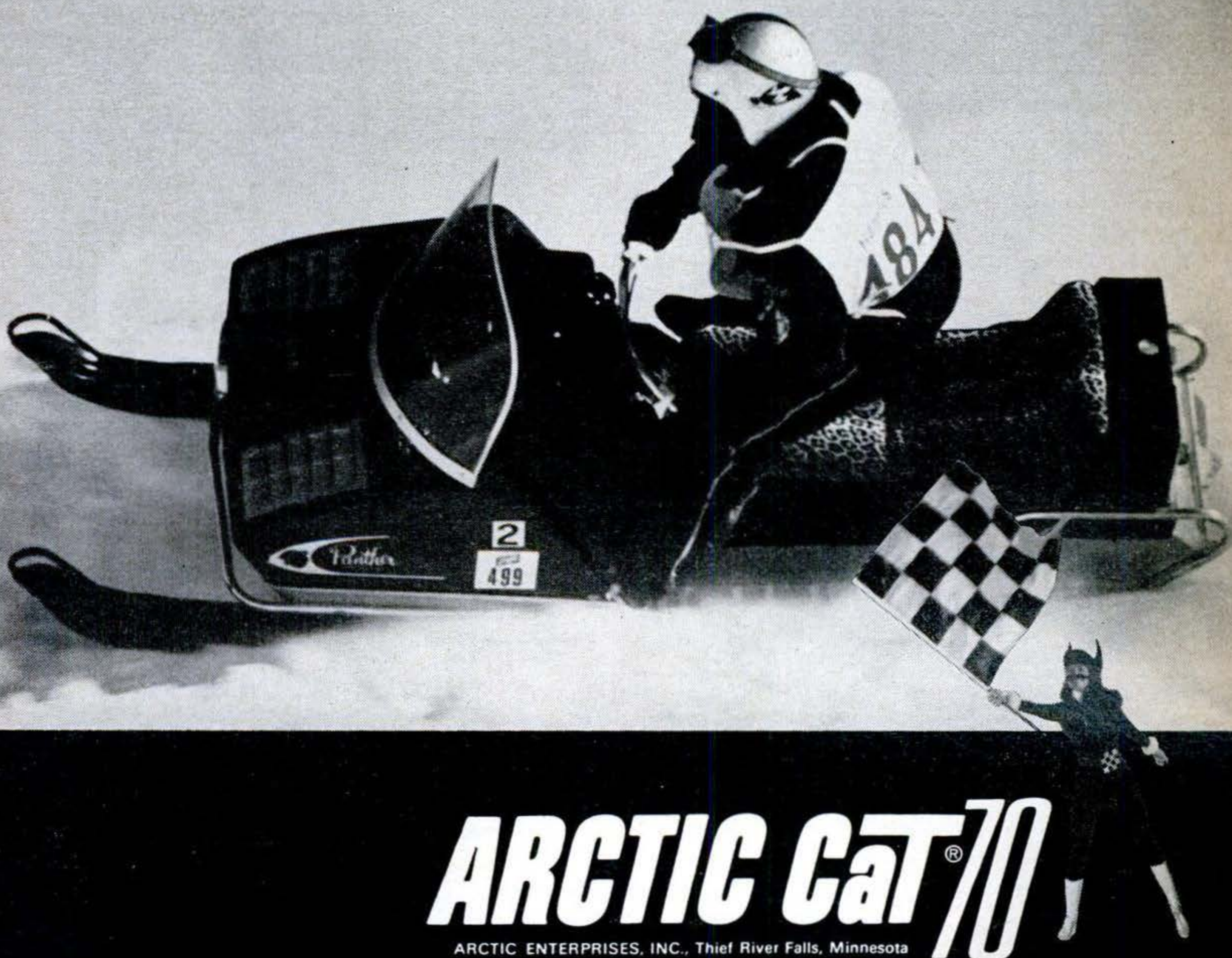
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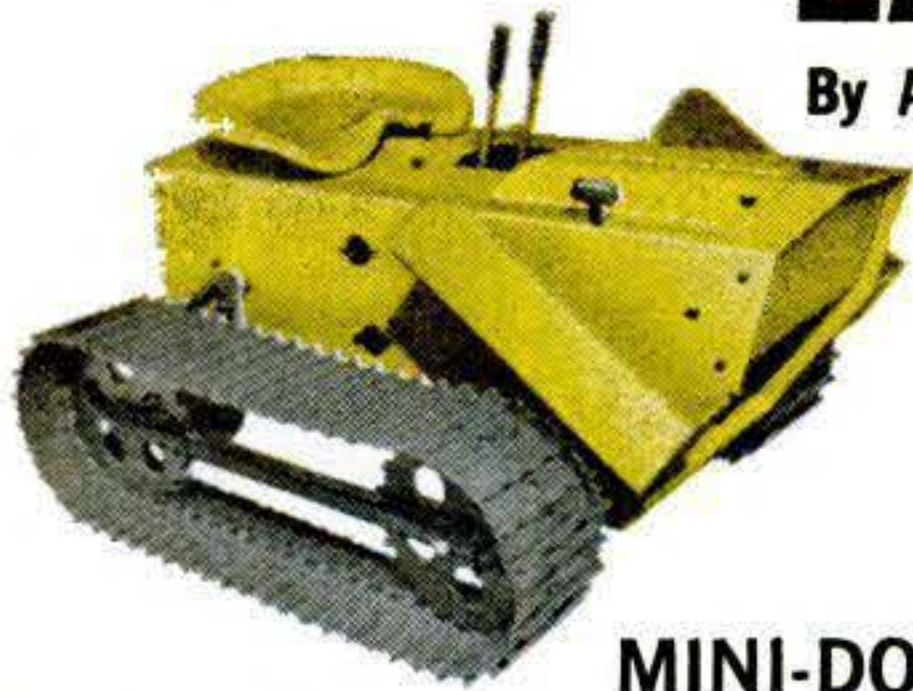


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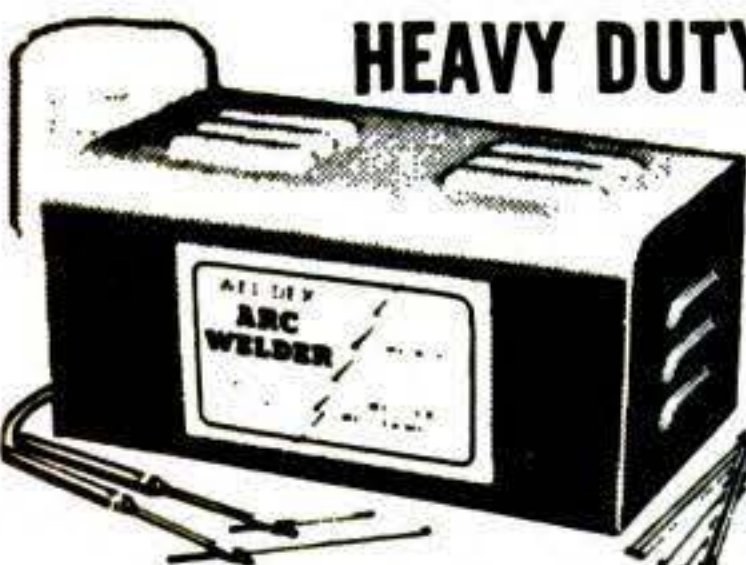
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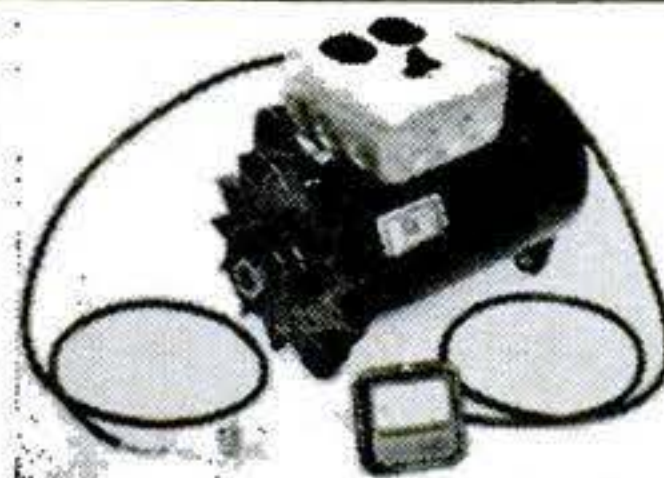
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New Roofing: Sticks and Looks Better

[Continued from page 131]

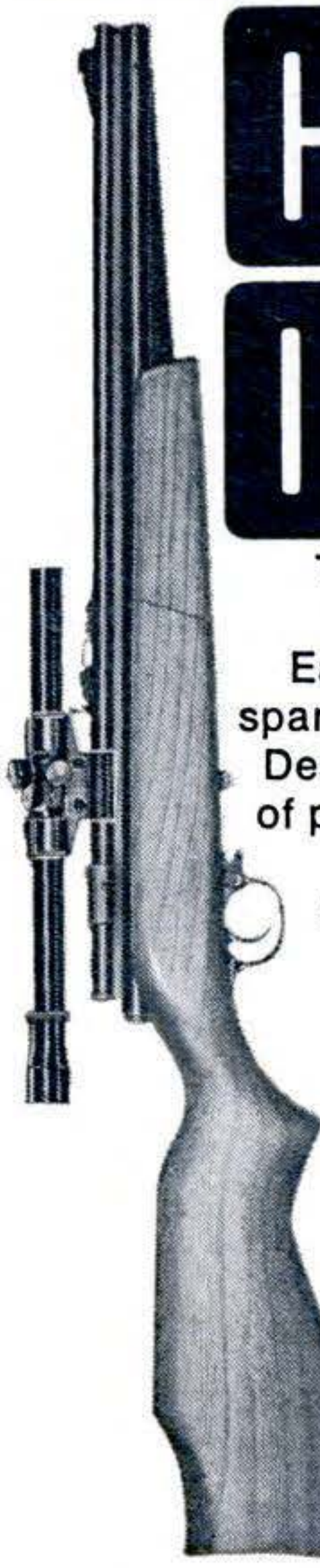
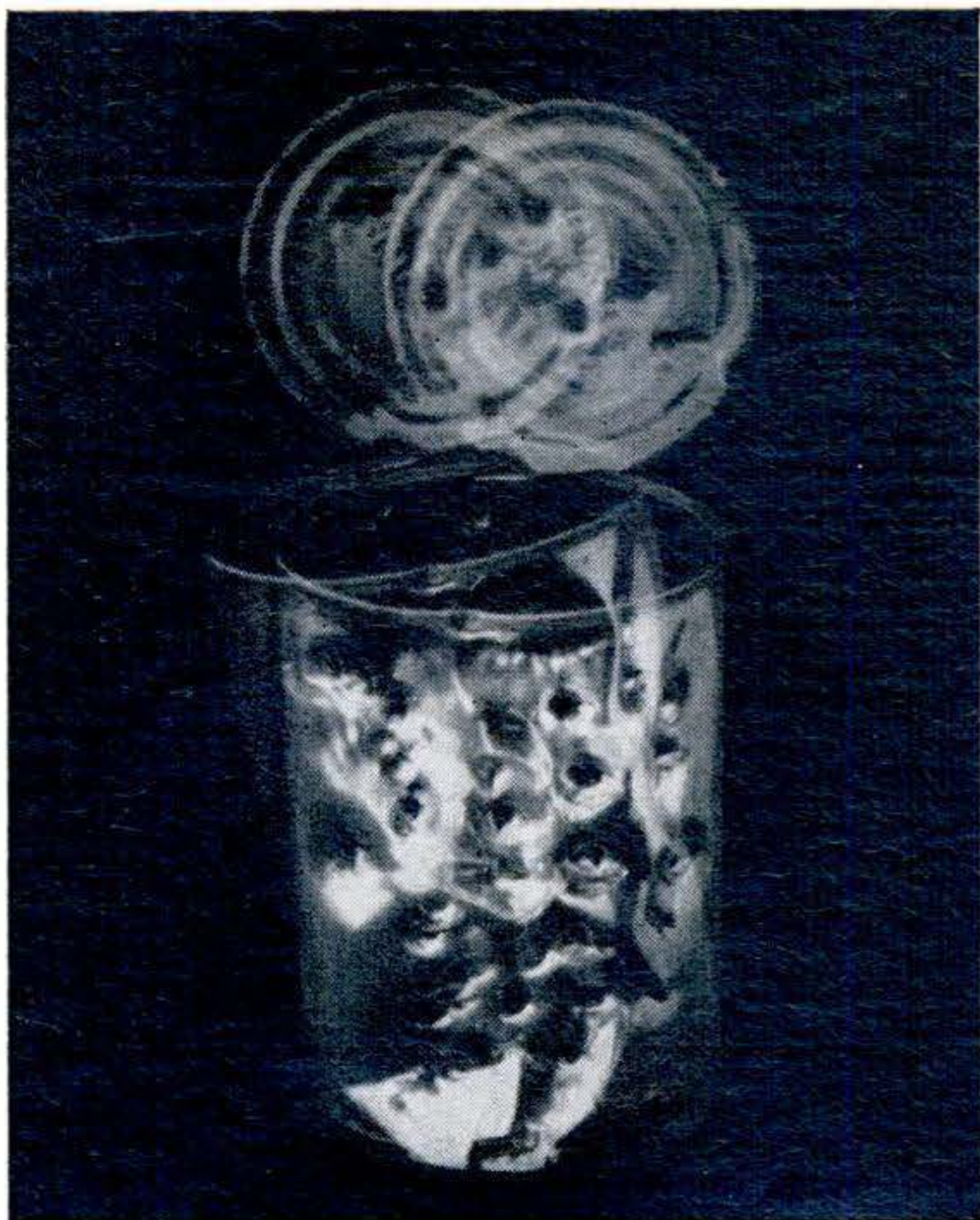
most familiar. Realistically textured, with jagged sloping edges, the slates come in a half-dozen colors that can be blended in various random mixes. Since each shingle is a separate piece, you can also vary the butt line. Though little more than half as heavy as natural stone, slates do require sturdy framing; they weigh about 540 pounds per square.

Newest of the mineral-base imitators is Bel-Air's wood simulation. It's called Bel-Air and is a dead ringer for weathered cedar; like the slates, it has a class-A rating. Bel-Air comes in individual shingles 16 inches long and in widths of six, eight, and 10 inches. There are matching accessories for hip, ridge, and starter shingles.

As with all mineral-base shingles, the weight is relatively high—420 pounds per square. This means that not every older home can stand the weight, since framing may not be strong enough. In many cases, reroofing may require the removal of all old roofing materials as a means of reducing total weight on framing.

Coming next: glass roofs. Latest news in residential roofing comes from an unexpected source: Corning Glass Works (Corning, N.Y. 14830). They've introduced a startling new roofing material—foamed ceramic. The fired material is in five-by-nine-inch wedge-shaped tabs that taper from an inch-thick butt. These are laminated to a standard asphalt strip and are installed like asphalt shingles. They're so light (225 lbs. per square) that they need no greater supporting structure than regular asphalt shingles. You can apply them over old asphalt (or roll roofing) without any underlayment. The tabs are durable, inert, fire-resistant—and come in five fadeproof colors. In place, they insulate the asphalt strips they cover, preventing sun-deterioration.

At the moment, Corning Ceramic-Tab is being marketed to builders in Oklahoma only. But if it tests out as expected, you'll doubtless be able to buy it in the future. Estimated price: \$37.50 per square—but it's a roof on which you'd never spend a cent for maintenance. It'll come with a 30-year guarantee and your problem may be to find metal flashings that will last as long as the roof! **PS**



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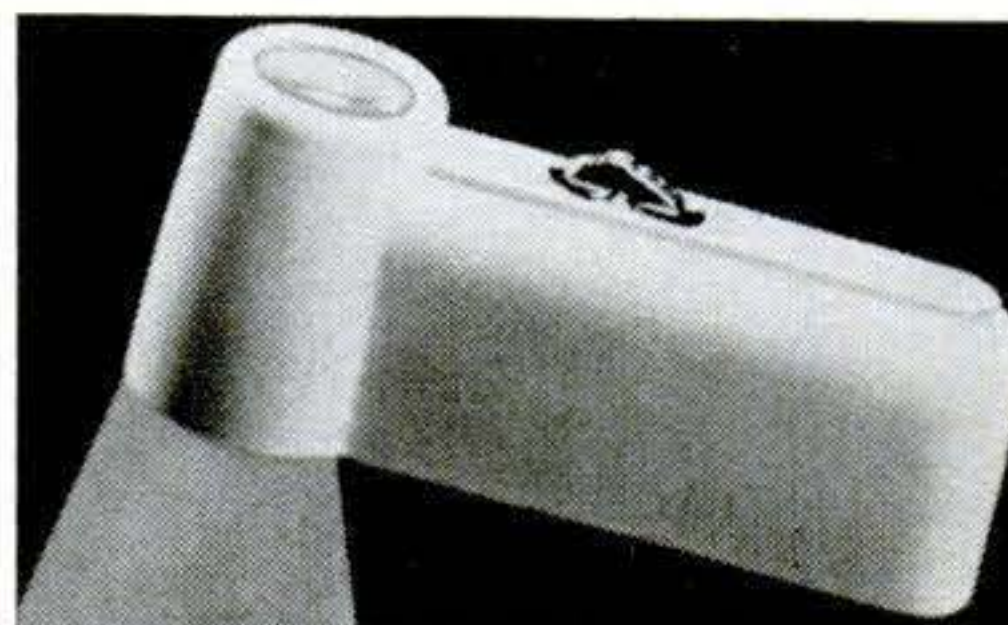
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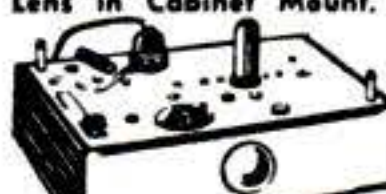
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Talking on a Light Beam

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A. The direct-to-you, "no middleman", club plan is just part of the answer. The other key is ABSClub's especially designed multi-use equipment. For example: the Microprojector quickly and easily converts into the Spectroscope, Photo Enlarger and Cloud Chamber Illuminator. Similarly, the Transit doubles as a Telescope Mount. Such multi-purpose design... plus club plan economy... makes possible this all-science program at a price everyone can afford.

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A. Yes. With the first kit members receive a list of the equipment and projects contained in each of the remaining nine kits. With this information they are able to choose the kit sequence that best suits their particular interest.

Q. Can members get their kits all at once instead of one-a-month?

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AMERICAN BASIC SCIENCE CLUB, INC.
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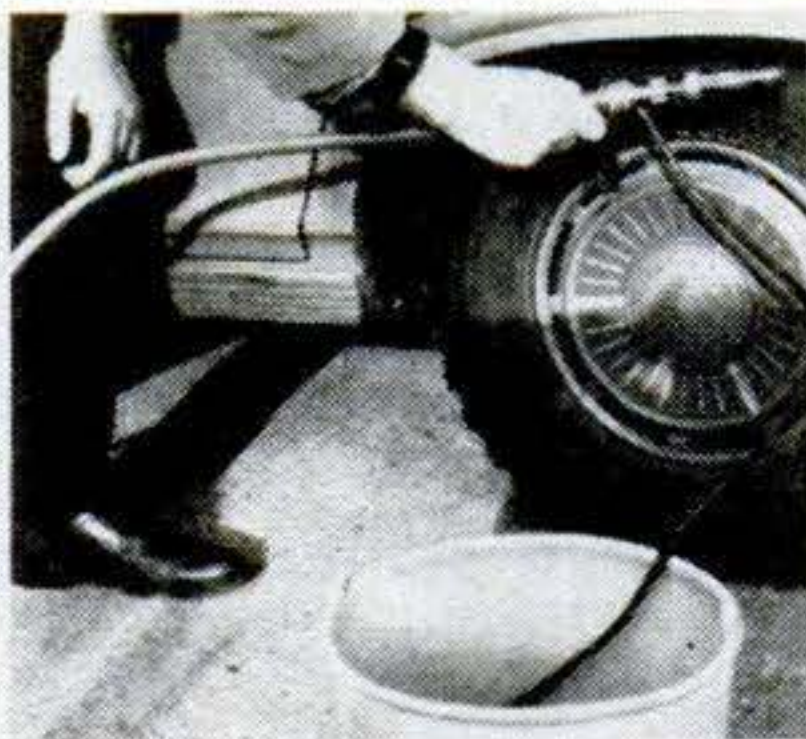
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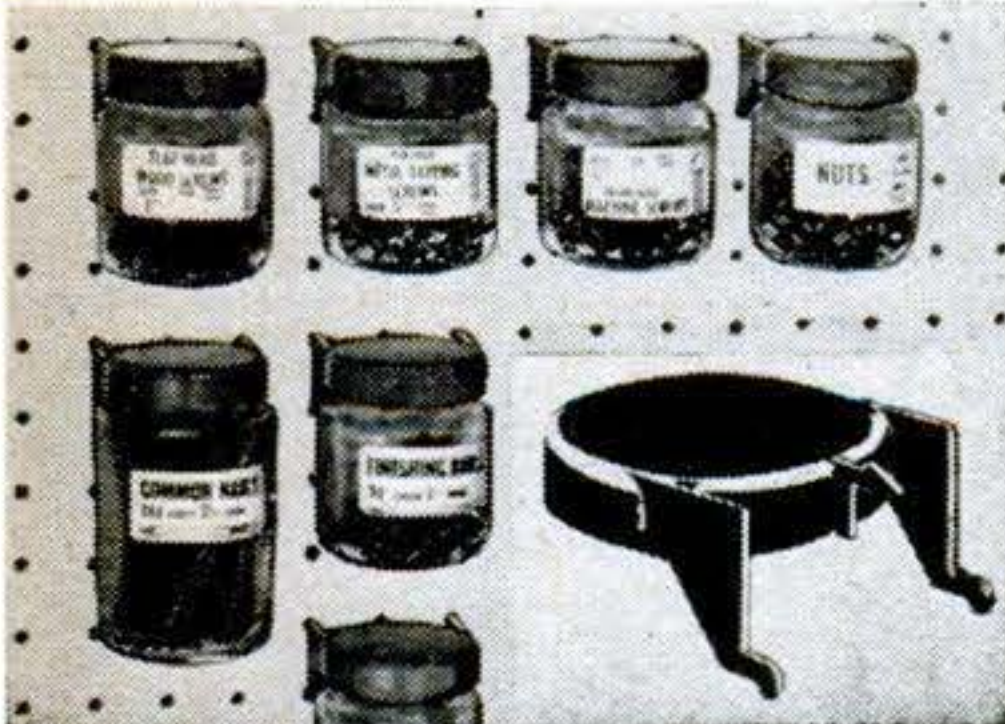
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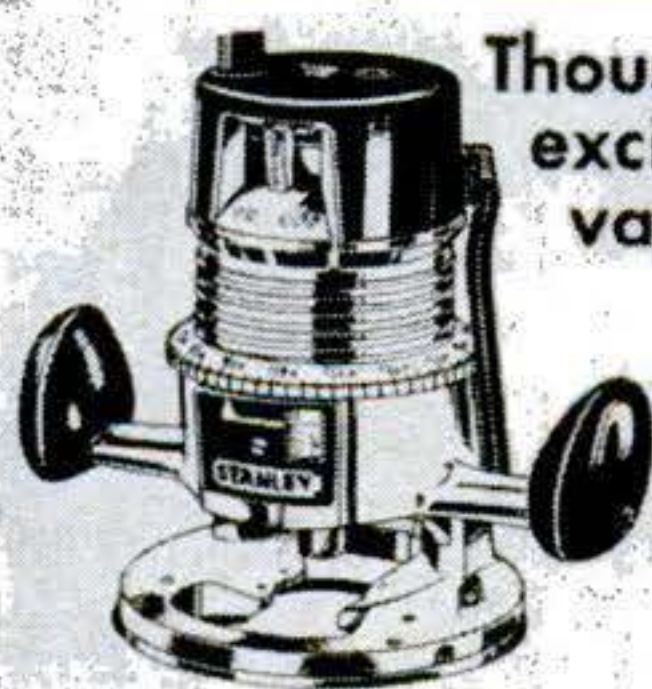
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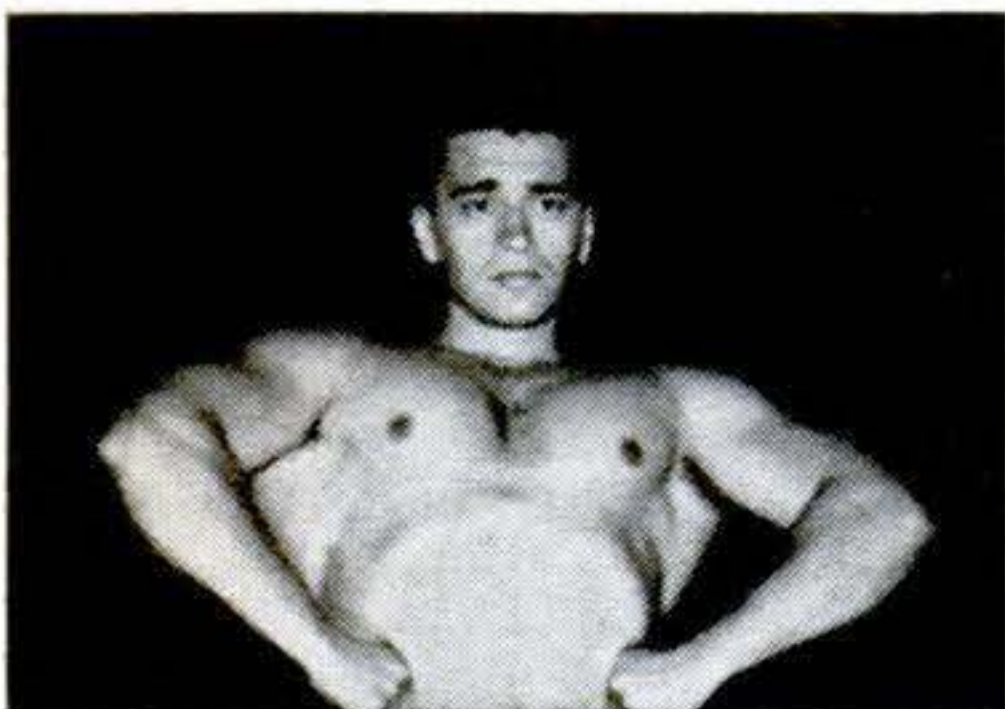
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that
bulge
goes,
or I
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For a speedy "Getaway" on the Slimmers Formula, slip on Slim-Gard . . . then take it easy, for while you're sitting around, watching TV, relaxing or eating, your waist, hips and small of the back are getting an effortless "going over" that takes inches off your soft belly without your even knowing it. It hugs your body gently but firmly, keeping warm air in — cool air out — trimming inches effortlessly away! Slim-Gard works effectively for the fat or slender man. Instructions are included for the fat man who wants to quickly lose 20 to 100 pounds . . . and for the slender fellow who wants to lose only a few inches without losing weight. And Slim-Gard is hidden — no one knows — nothing shows . . . except the inches that go! You're guaranteed impressive results in 10 days or your money back.

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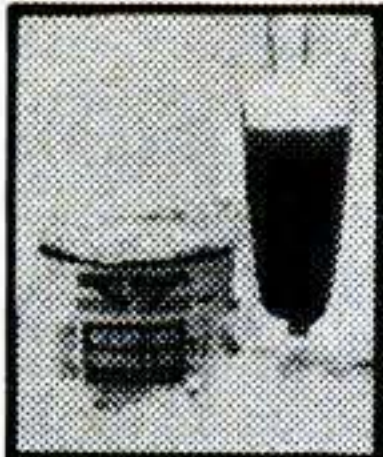
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2 "SLIMMER" SHAKE

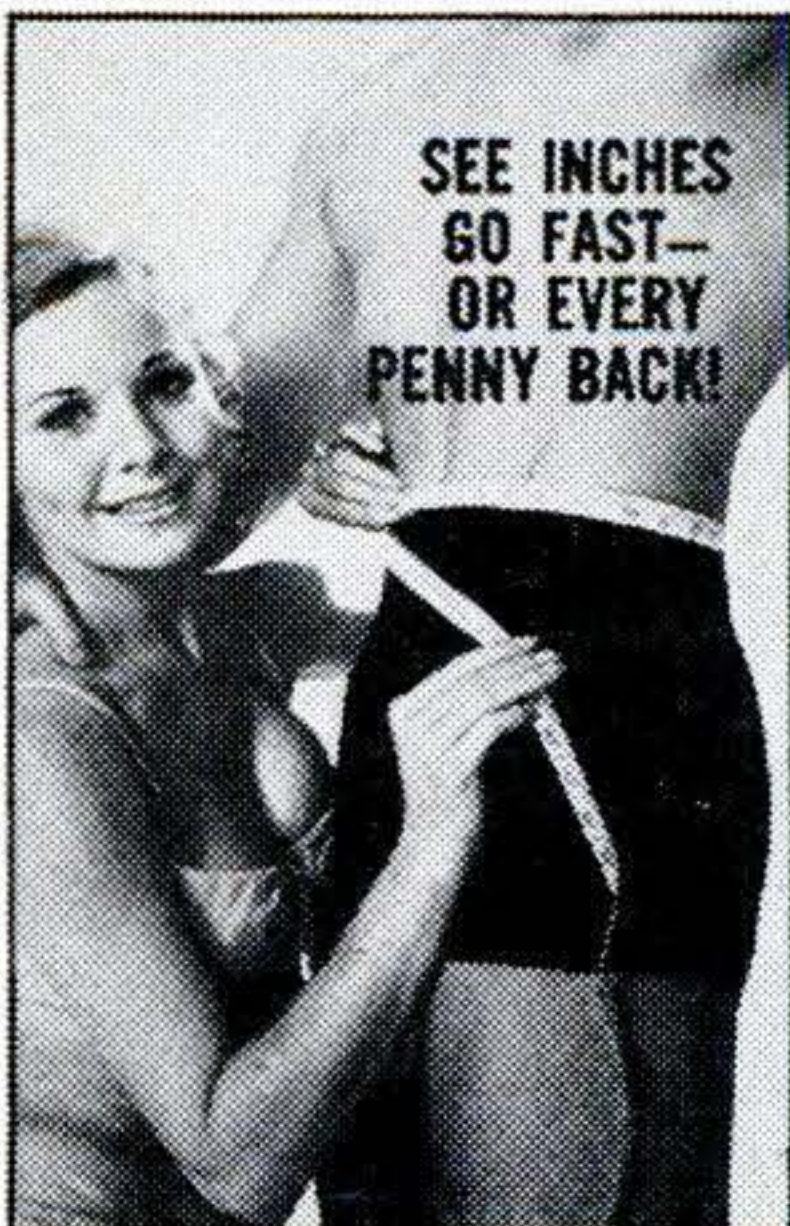
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SLIM DOWN — SHAPE UP — OR IT COSTS YOU NOTHING!



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**3 SLIM GARD and
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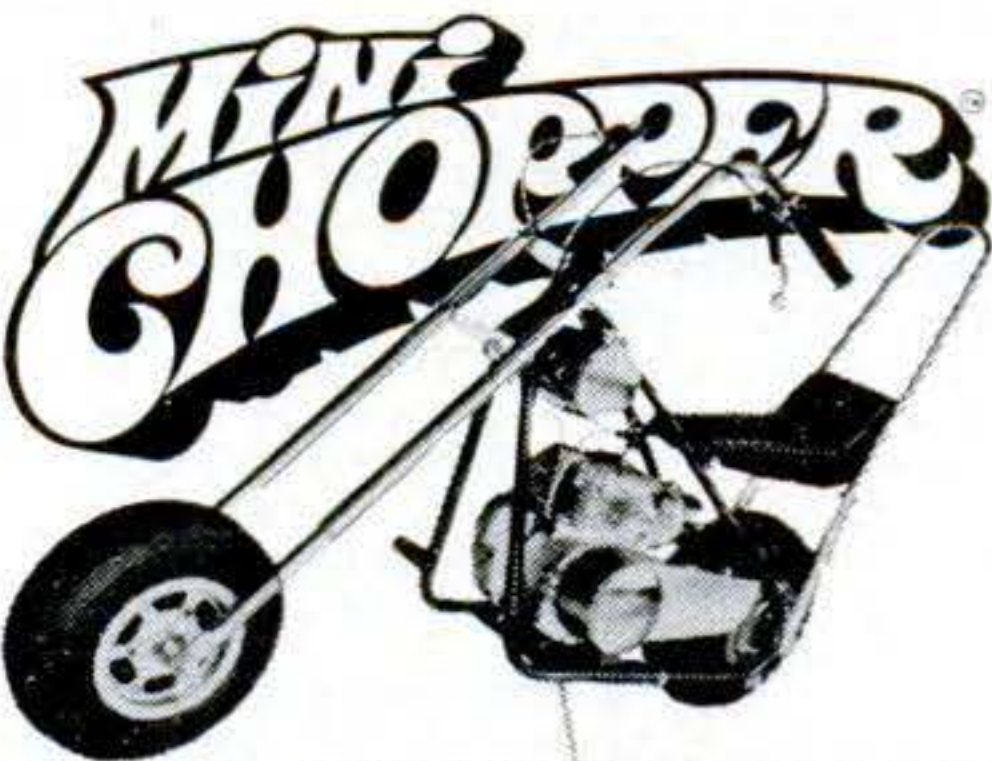
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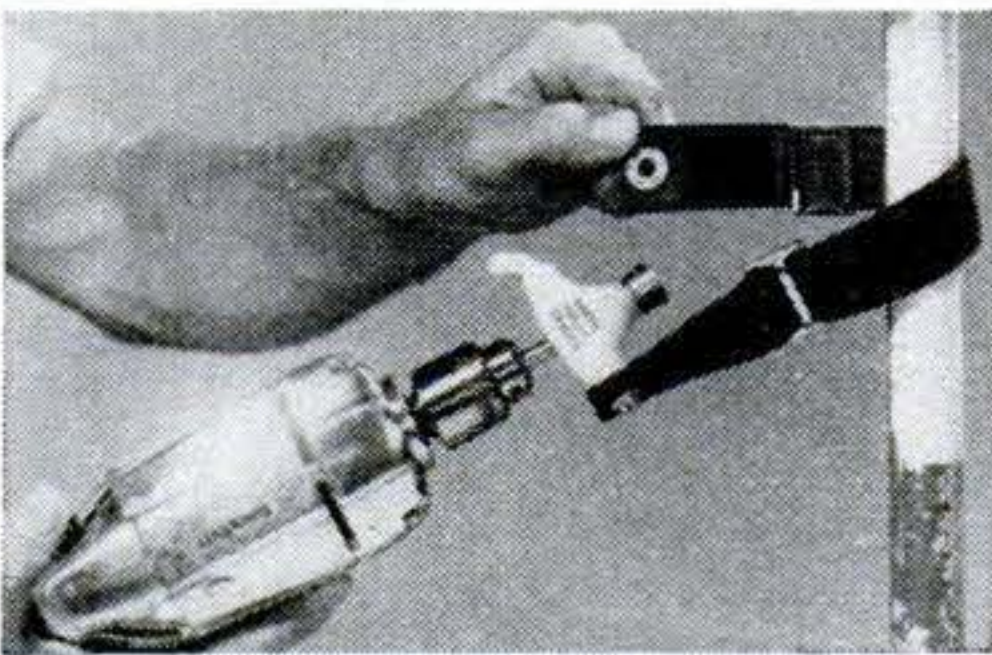
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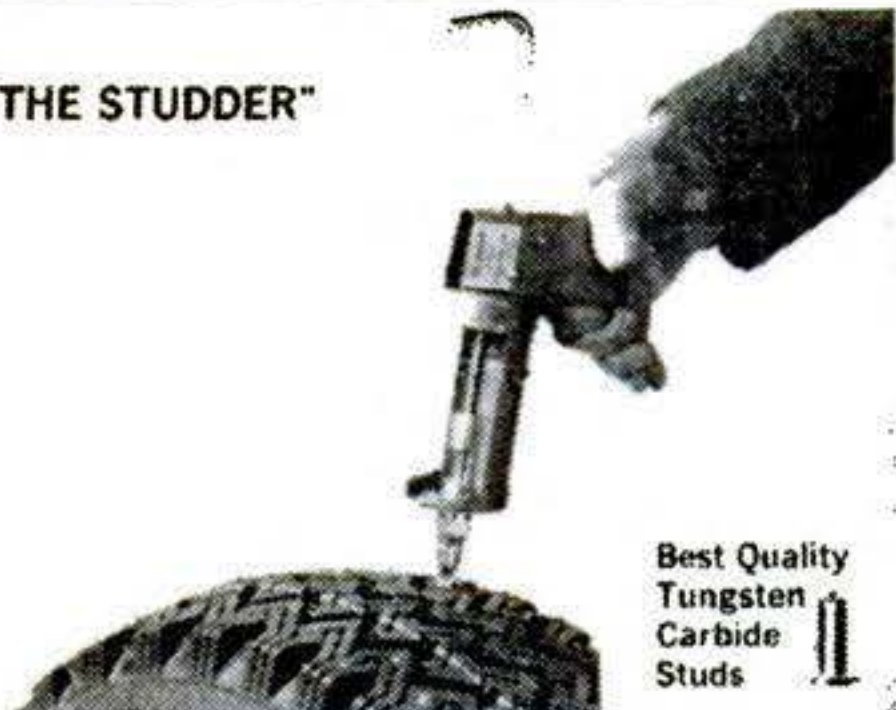
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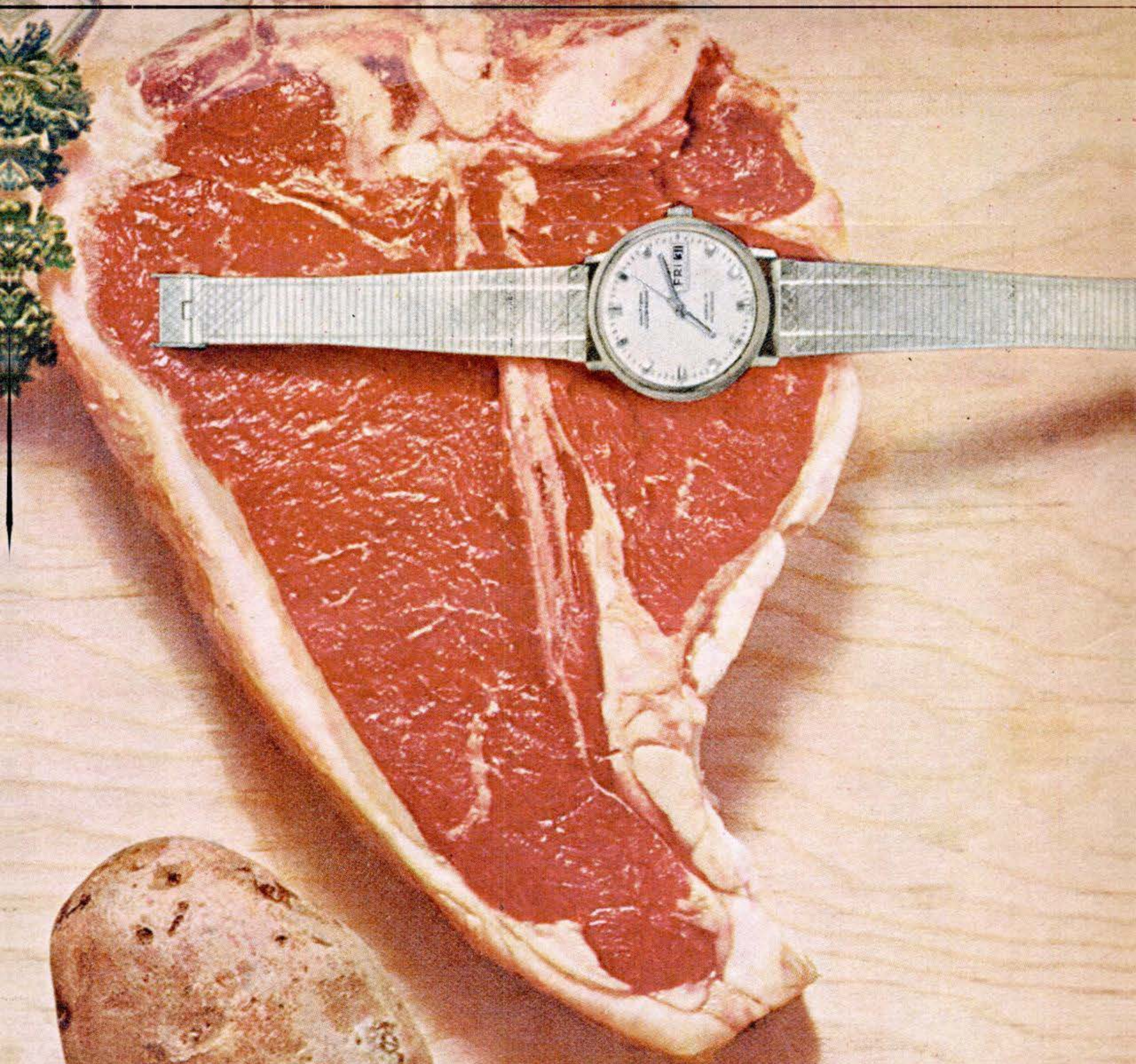
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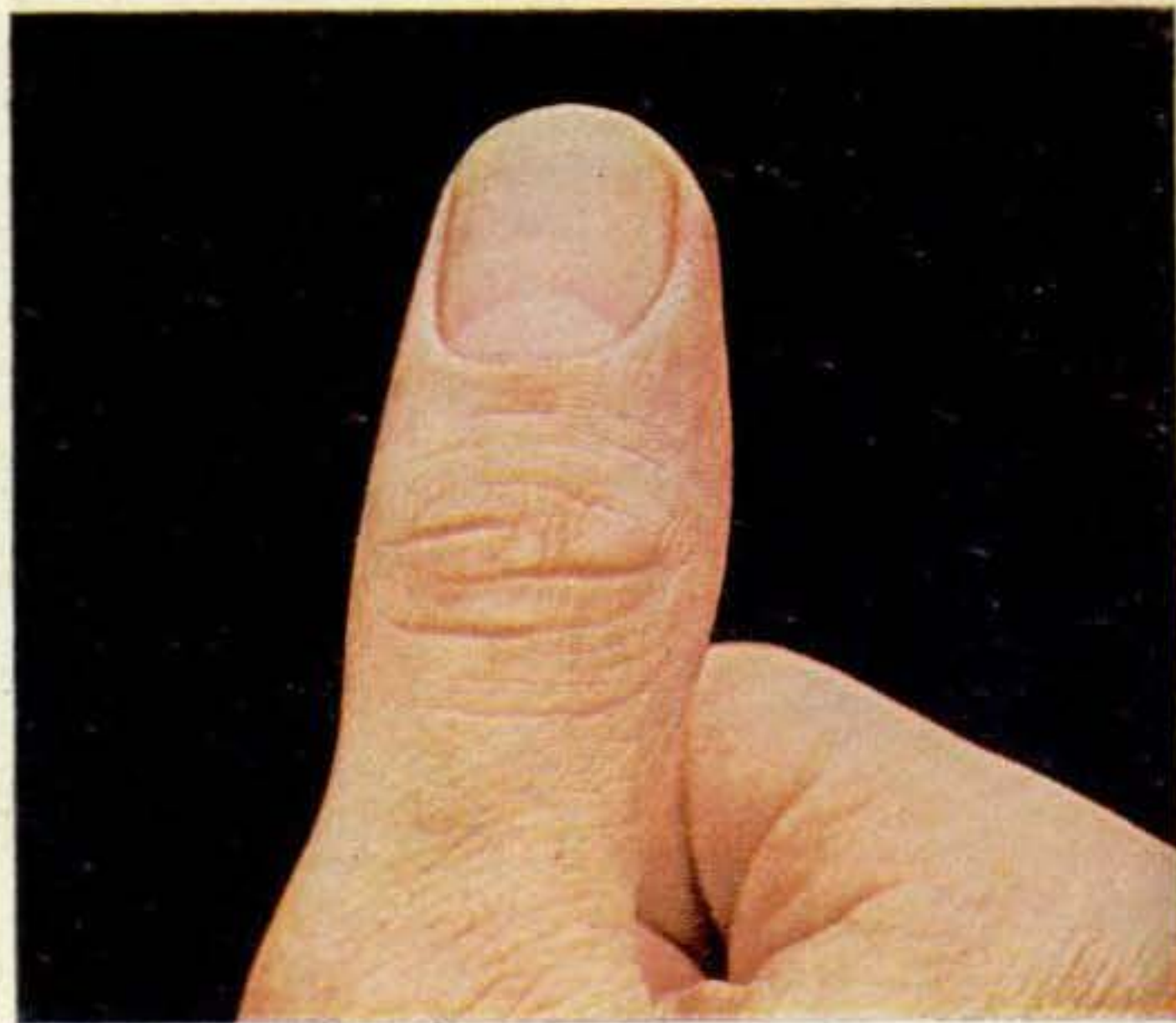
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